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RIDE TEST RESULTS FOR THE FAMECE DUMPER AND COMPARISON VEHICLES--ETC(U)
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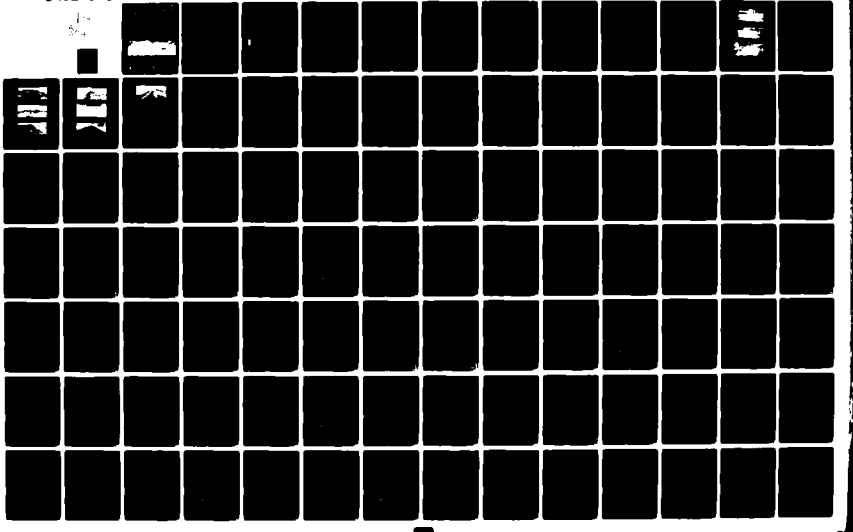

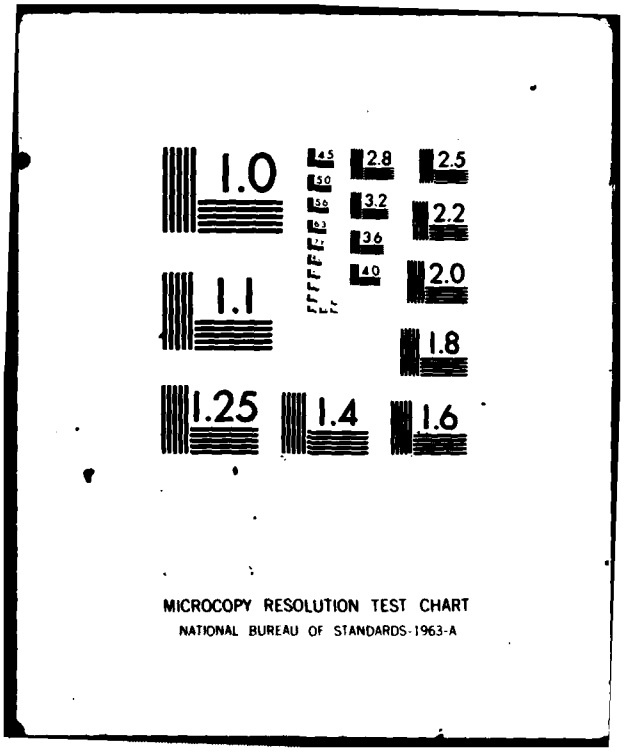
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LEVEL II

TECHNICAL REPORT GL-81-1

RIDE TEST RESULTS FOR THE FAMECE DUMPER AND COMPARISON VEHICLES

by

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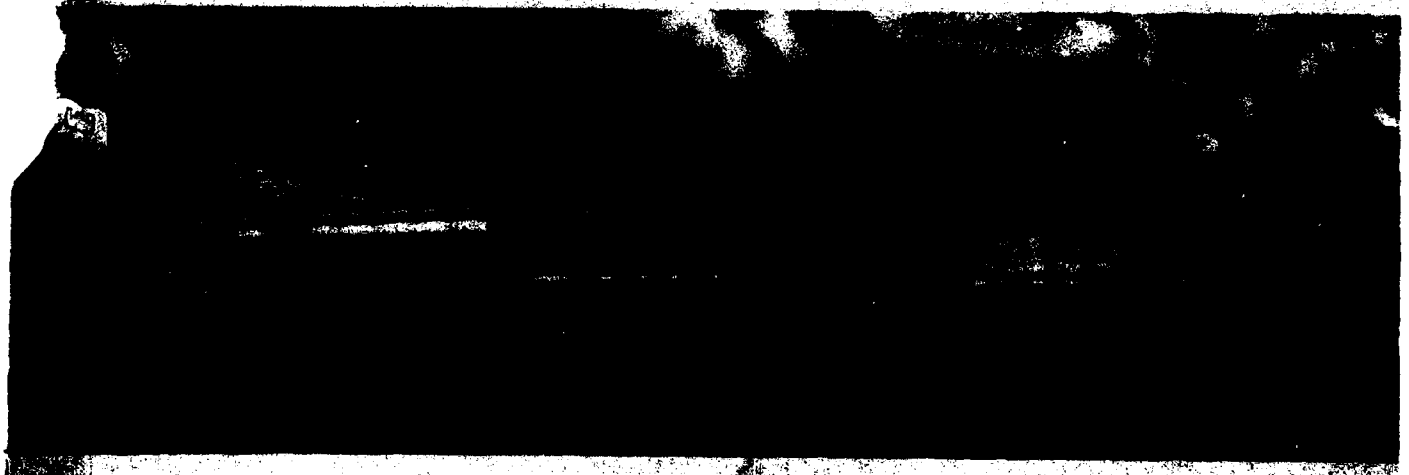
January 1981
Final Report



Prepared for Project Manager, Family of Military Engineer Construction Equipment and Universal Engineer Tractor (FAMECE/UET)
Fort Belvoir, Virginia 22060

Under Project Order No. A9330

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number): Ride tests were conducted with the dumper version of The Family of Military Engineer Construction Equipment (FAMECE), the M51, 5-ton dump truck, and the John Deere (JD544A) front-end loader in two areas adjacent to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. The purpose of the tests was to compare the ride quality of the vehicles at several measurement points in the cab and cargo areas (except front-end loader) and to determine the feasibility of using the FAMECE dumper or the M51, 5-ton dump truck, as a troop carrier around construction sites. (Continued)

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20. ABSTRACT (Continued).

The loader was included in the comparison testing because it is an unsprung vehicle, as is the FAMECE.

The FAMECE dumper was tested in both the empty and loaded conditions, at tire pressures of 55 and 45 psi, and with the driver's seat under pressure (Bostrom suspension seat) and locked out of suspension (to determine effect of suspended seat on ride response at the driver's station). The M51, 5-ton dump truck, was tested in the empty and loaded configurations at 35-psi tire pressure, while the John Deere 544A front-end loader was tested in only the empty condition at 50-psi tire pressure.

Vertical ride response data were measured on the FAMECE and the M51 at the driver's station, the observer's station, and the left-center, right-center, and rear-center cargo areas. The JD544A loader data were measured at the driver's station and at the rear hitch point of the loader. Ride response data at 6 w of absorbed power in the vertical direction (AP_{vt}) were obtained from plots of the field data for each test course. The terrain surface roughness corresponding to each test course was then used with the AP_{vt} values to develop characteristic ride performance curves for each measurement point on the test vehicles for each test condition. These curves were then compared to determine comparable ride performances of the vehicles.

Results of the testing indicate that the ride performance at the driver's station of the FAMECE was somewhat better without the driver's seat pressurized, and the best ride performance (of the conditions tested) was attained with the FAMECE loaded, tire pressure at 45 psi, and driver's seat not pressurized. The poorest ride of the five measurement points on the FAMECE at all loading configurations was obtained at the rear center of the cargo area. The ride performance as a troop carrier for the M51, 5-ton dump truck, at 35-psi tire pressure was slightly better than for the FAMECE at both 55- and 45-psi tire pressures. The ride performance of the M51 at the driver's station was slightly better than for the other four measurement points on the vehicle. The ride performance at the driver's station for the test vehicles, empty, was best for the M51, 5-ton dump truck, followed by the FAMECE dumper and JD544A loader, which were about the same.

PREFACE

Personnel of the U. S. Army Engineer Waterways Experiment Station (WES) conducted the study reported herein during the period September-December 1979 for the Project Manager's Office (PMO) for the Family of Military Engineer Construction Equipment (FAMECE) and Universal Engineer Tractor (UET) at Ft. Belvoir, Virginia, under Project Order No. A9330, dated 12 September 1979.

The overall study was under the general supervision of Dr. D. C. Banks, Acting Chief, Geotechnical Laboratory (GL), and Mr. A. A. Rula, Chief, Mobility Systems Division (MSD), GL, and under the direct supervision of Mr. B. G. Schreiner, Chief, Engineer Test Group, MSD. Mr. W. E. Willoughby, MSD, directed the field program and prepared the report. Messrs. C. R. May, S. M. Hodge, and L. B. Naron, MSD, contributed significantly to the reduction and analysis of the test data.

Acknowledgement is made to MAJ David Pierce, PMO, FAMECE/UET, for his support and assistance in the coordination of the field testing.

COL Nelson P. Conover, CE, was Commander and Director of the WES during the study and preparation of this report. Mr. Fred R. Brown was Technical Director.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

Units of measurement used in this report can be converted as follows:

Multiply	By	To Obtain
feet	0.3048	metres
inches	25.4	millimetres
miles (U. S. statute)	1.609344	kilometres
miles (U. S. statute) per hour	1.609344	kilometres per hour
pounds (force)	4.448222	newtons
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.4535924	kilograms
tons (force)	8896.444	newtons
tons (2000 lb, mass)	907.1847	kilograms

RIDE TEST RESULTS FOR THE FAMECE DUMPER AND COMPARISON VEHICLES

PART I: INTRODUCTION

Background

1. In June 1979, the Project Manager's Office for the Family of Military Engineer Construction Equipment (FAMECE) and Universal Engineer Tractor (UET) at Fort Belvoir, Virginia, requested that the U. S. Army Engineer Waterways Experiment Station (WES) perform a ride test evaluation of the FAMECE dumper. The purpose of this program was to evaluate the operator and passenger comfort in the vehicle as the vehicle was driven over standard roughness courses up to the maximum speed of the vehicle for the test condition. In addition, the cargo bed of the vehicle was instrumented to ascertain the ride comfort in the cargo bed of the vehicle to determine the feasibility of using the FAMECE dumper as a troop carrier around engineer construction sites.

2. For comparison, ride tests were also conducted over the same courses with the M51, 5-ton* dump truck, which also could be used as a troop carrier when necessary. Another unsprung piece of construction equipment, a small John Deere (JD544A) front-end loader was instrumented at two locations (no cargo area) to compare with the ride quality of the FAMECE dumper, which also is unsprung.

Purpose

3. The purposes of the WES study were to:

   a. Obtain experimental ride data for three test vehicles.

   b. Use experimental data to develop the appropriate ride relations for the vehicles.

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.

c. Make a comparison of the FAMECE dumper, M51 dump truck, and front-end loader on the basis of ride test results and location of measured response data.

Scope

4. Field tests were conducted on the WES reservation, at the Vicksburg Airport, and on leased property adjacent to the WES, over eight test courses with three test vehicles to obtain ride and cargo area (except front-end loader) vibration data. Test conditions were varied for the FAMECE to ascertain the best configuration of load, seat pressure, and tire inflation pressure based on the various configurations. Results of all the tests were reduced, analyzed, and used to compare ride performances for the three vehicles in the form of performance curves of vehicle speed-terrain roughness over the selected terrains.

PART II: FIELD TESTS

Test Vehicles

5. The following vehicles, which are pictured in Figure 1, were field tested to determine their ride response characteristics:

Vehicle	Vehicle Test Weight, Empty, lb	Approximate Payload, lb	Vehicle Test Weight, Loaded, lb
FAMECE dumper	28,160	21,000	51,160
M51, 5-ton dump truck	22,170	10,000	32,455
John Deere (JD544A) front-end loader	18,380	--	--

The vehicles were tested at the empty and loaded vehicle test weights indicated, although the John Deere front-end loader was not tested in a loaded configuration. Tires on all test vehicles were inflated to the pressure recommended by the manufacturer for cross-country travel, i.e., 55 psi for the FAMECE, 35 psi for the M51, and 50 psi for the loader. The FAMECE was also tested at 45 psi in both configurations on several test courses to determine the effects of reduced tire pressure on the ride characteristics of the vehicle. The pressurized seat for the driver of the FAMECE, which normally carries 100 psi, was also tested without any pressure, but bolted to the frame, so that the effects of the suspended driver position relative to the vehicle frame could be determined. General vehicle data are presented in Table 1.

Selection, Location, and Description of Test Courses

6. In selecting courses to develop the ride relations, courses were sought whose surfaces were firm and of approximately constant roughness throughout without evident pattern (i.e., had essentially random variations in local elevations). Also, each course was relatively level (no slope) for about 300 ft. Eight courses were selected with individual roughness ranging from relatively smooth to rough. The locations of test courses 1-7 are shown in Figure 2, with photographs of these courses presented in Figure 3.

A. FAMECE dumper

b. M51, 5-ton dump truck

c. John Deere (JD544A) front-end loader

Figure 1. Test vehicles

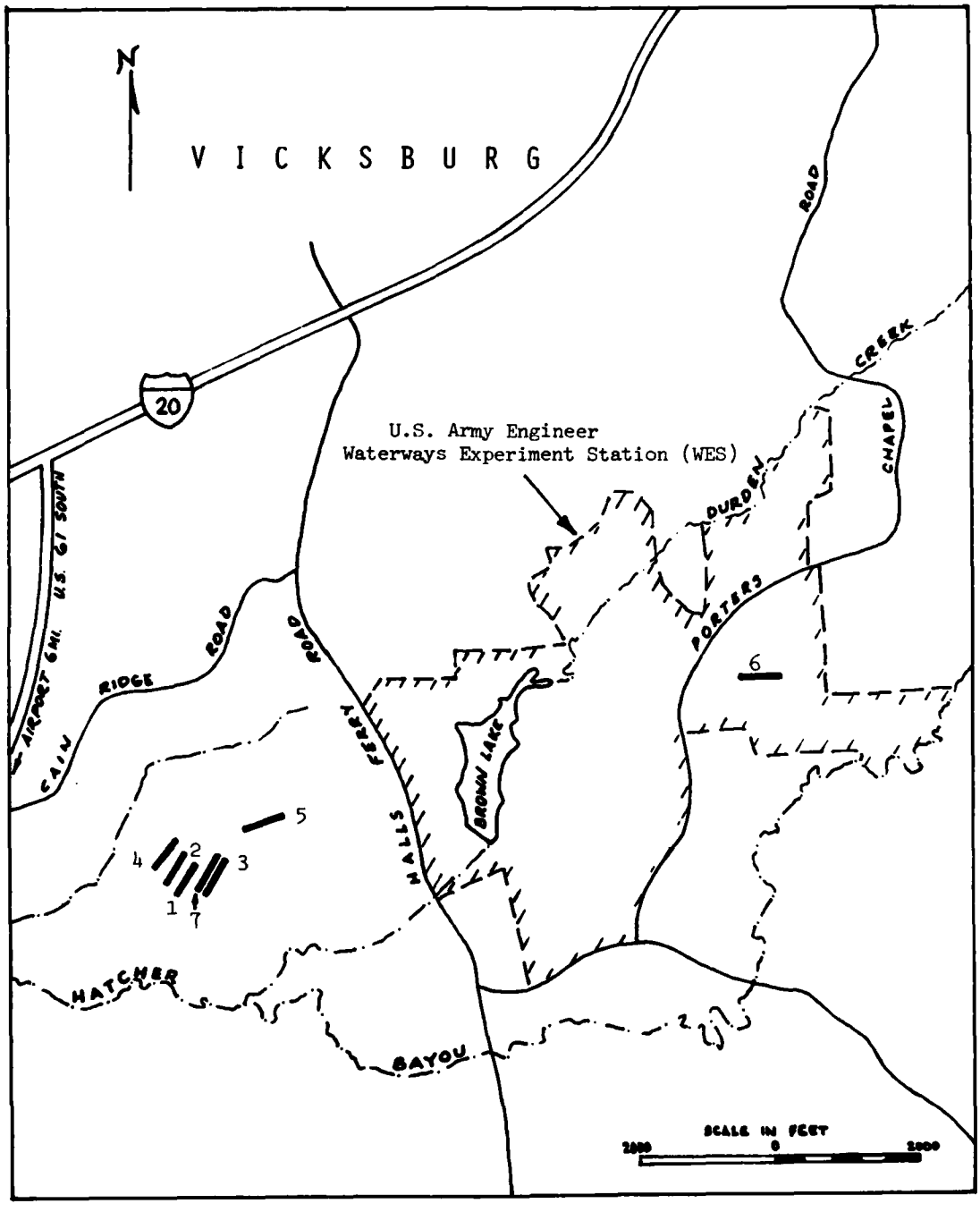
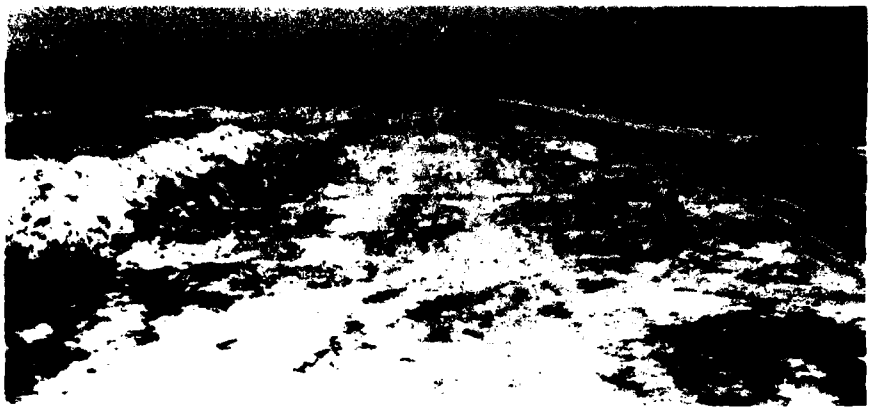


Figure 2. Location of ride test courses near the WES reservation



a. Course 1

b. Course 2

c. Course 3

Figure 3. Ride test courses (Sheet 1 of 3)

d. Course 4

e. Course 5

f. Course 6

Figure 3. (Sheet 2 of 3)

g. Course 7

Figure 3. (Sheet 3 of 3)

7. Test courses 1, 2, and 7 were constructed in an area that had been cleared by a bulldozer, leaving the ground surface rough with shallow trenches and small mounds. Construction equipment was used to ditch the selected courses to permit natural weathering to alter the surface of the courses. Cement was spread over the surface and a tracked armored personnel carrier (M113A1) was used to pack the courses after the addition of water sprayed from a water truck. An M151, 1/4-ton truck, with known vibrational response over similar terrain was used to tune the courses to natural cross-country random vibrations. The courses were devoid of vegetation and level; the soil type was lean clay (CL-ML), as classified by the Unified Soil Classification System (USGS). Courses 3, 4, and 5 were selected in natural grass-covered terrain in the same soil area as courses 1, 2, and 7. The ground surface of courses 3, 4, and 5 was naturally weathered and considered to be realistic cross-country terrain. Course 6 was a level stretch of gravel road, which had been graded smooth with a motor grader. In addition, the paved runway at the Vicksburg Municipal Airport was used as the course for maximum speed tests.

8. Surface profiles were measured for each course with a survey rod and level, elevations being taken at intervals of 1 ft for the

total length of each course. These profile data were detrended to remove any cyclic terrain influences, and surface roughness in terms of rms elevation* values developed for each course. The test courses are identified as follows:

Test Course	Surface Roughness (rms), in.	Length, ft
1	2.69	300
2	1.75	300
3	0.96	300
4	0.71; 0.96; 0.76	300
5	0.41; 0.47	300
6	0.24	300
7	0.42	300
Airport	0.09	300

9. As noted in the tabulation above, several rms values were used in tests for courses 4 and 5 because of slight changes in the surface profile of the two courses after vehicle traffic during testing. Profiles were taken for each course after each test sequence, but only courses 4 and 5 exhibited any significant changes in surface roughness. The surface roughness values of these two courses are very important in determining the shape of the characteristic ride performance curves (see Part III) for each vehicle configuration; therefore, close monitoring was required to ensure correct surface roughness values for each sequence of tests.

Instrumentation for Measuring Vehicle Dynamic Responses

10. The instruments used to measure vehicle driver, passenger, and cargo responses during the ride tests were mounted at several locations in the cab and cargo area of the vehicles. In the FAMECE cab, three orthogonally positioned linear accelerometers were mounted on the floor between the driver's and the passenger's seat and connected to a WES portable ride meter in the cargo bed of the vehicle. An additional

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* Root-mean-square (rms) elevation in inches is the measure of terrain surface roughness characterized by the WES for ride vibration criteria.

vertically oriented accelerometer was mounted on both the driver's and the observer's seat. In the cargo area of the FAMECE, a package of three orthogonally positioned linear accelerometers and two rotational accelerometers were mounted at the center of gravity of the vehicle (near the front of the cargo bed, on the steel deck). Each package of three linear accelerometers measured the bounce (vertical), fore-to-aft, and side-to-side accelerations, while the two rotational accelerometers measured the pitch and roll accelerations. Single vertical accelerometers were also placed (a) at the left center of the cargo area on the center slat of a three-slat troop seat, (b) at the left front of the cargo bed on the steel deck, (c) at the right center of the cargo area opposite the troop seat accelerometer but on a rigid seat welded to the steel seat in the bed above the right rear wheel, (d) at the center of the cargo bed at the rear end of the dump bed but on the steel deck, and (e) on the front axle at the left wheel. The right-center cargo seat (c) was necessary for safety reasons because of the high vertical accelerations in the cargo area that were expected during the ride tests. A passenger was placed in both the observer and cargo seats and buckled in with seat belts to monitor troop ride quality in the passenger and cargo areas. In addition, the shock-mounted driver's seat was tested with 100 psi and with the seat bolted to the frame to negate any shock function during testing.

11. In the M51, 5-ton dump truck, the three orthogonally positioned linear accelerometrs were mounted on the floor of the cab beneath the driver's seat. An additional vertically oriented accelerometer was mounted on the driver's seat (and beneath the observer's seat). The same FAMECE five-position center-of-gravity accelerometer package was placed at the front of the cargo bed of the M51. A slat troop seat, similar to that of the FAMECE, was installed in the left cargo area of the M51, and a vertically oriented accelerometer was placed on the center slat, as in the FAMECE. Furthermore, single, vertically oriented accelerometers were mounted on the steel deck at the right center of the cargo area (opposite the one on the left-slat seat), on the steel deck at the rear end of the cargo area along the

longitudinal center line of the vehicle, and on the front axle at the left wheel.

12. The instrumentation mounted on the John Deere front-end loader consisted of three orthogonally positioned accelerometers mounted on the cab floor beneath the driver's seat, a single vertical accelerometer on the driver's seat, a single vertical accelerometer at the left front wheel, and a single vertical accelerometer mounted at the hitch point at the rear of the vehicle.

13. For the analysis described in Part III, only the driver's and the observer's seat vertical accelerometers, the left- and right-center cargo accelerometers, and the rear cargo (or hitch point of loader) accelerometer data will be used. The other recorded data will later be used for input to WES submodels of the Army Mobility Model (AMM)* to improve the accuracy of performance predictions for military and commercial vehicles.

14. All signals from the accelerometers were recorded on an FM magnetic tape (which was processed later on the WES analog computer) by a 14-channel heavy-duty recorder with an associated signal processor and a 30-v power source, which were mounted on the vehicle. The ride meters converted the acceleration signals to absorbed power, a measure of ride severity.** At the end of each test, the values of total absorbed power were recorded as well as the elapsed time obtained from the ride meters.

Test Procedures

15. Several tests were conducted with each vehicle over each ride test course at selected speeds ranging from about 2 mph to the maximum

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* M. P. Jurkat, et al. 1975. "The AMC '74 Mobility Model," Technical Report 11921 (LL149), U. S. Army Tank-Automotive Research and Development Command, Warren, Mich.

** F. Pradko, L. Richard, and V. Kaluza. 1966. "Theory of Human Vibration Response," presented at the Winter Annual Meeting and Energy Systems Exposition of the American Society of Mechanical Engineers, New York.

safe speed over the course as determined by the driver. Vehicle speed was increased from test to test until the ride limit or the maximum power-controlled speed was reached.

16. Each test began with the vehicle positioned a sufficient distance from the beginning of the test course to enable the driver to reach the desired test speed before entering the test course. This speed was maintained as constant as possible throughout the length of the course. An observer rode in the vehicle (except the loader) during each test, operated the ride meter, and narrated details of the tests onto magnetic tape. At the end of each test, the average absorbed power and average speed were calculated from elapsed time, total vertical absorbed power (obtained from the ride meter), and the length of the test course. This procedure provided on-the-spot indications of average absorbed power versus speed for use by field personnel in planning the sequence of the tests to ensure that sufficient tests were conducted to develop the necessary relations. All data were recorded on an FM magnetic tape, including observer comments during the course of testing.

17. The basic test data were plotted and grouped by test vehicle and test condition in Plates 1-79. The characteristic ride performance curves for each test vehicle and condition obtained from field test data are followed in each set by measured field response data. The data are grouped by the measured response point on the vehicle such that Plates 1-17 represent ride response at the driver's station; Plates 18-32, ride response at the observer's station (except loader); Plates 33-47 ride response at the left-center cargo (except loader); Plates 48-62, ride response at the right-center cargo (except loader); and Plates 63-79, ride response at the rear-center cargo (or hitch point on loader). Where tests were conducted on only one or two courses with a vehicle configuration, no ride performance curves are shown. The data described in Part III will be referred to as ride performance curves, denoting the characteristic ride curve developed from the field test data that will be referred to as ride response data.

PART III: ANALYSIS OF TEST DATA

Ride Test Results

18. The basic data describing the ride and cargo responses from the ride tests are plotted in Plates 1-79 for the three vehicles. The plates are of two types, ride performance curves or measured ride response data, and will be referred to by type (see paragraph 17).

19. Ride quality over continuous terrain is presently based on absorbed power at the driver's seat and is used as a basis for assessing the speeds at which a driver will operate his vehicle. Absorbed power, derived from acceleration measurements, is the rate at which vibrational energy is absorbed by a human. Six watts of absorbed power in the vertical direction (AP_{vt}) at the driver's seat is the measure of ride quality presently used in assessing the speeds at which a driver will operate his vehicle. Absorbed power measured in other directions, such as fore-and-aft and side-to-side, is being studied from results of field test programs to determine its effects on the driver's perceptions of ride quality and his corresponding driving behavior. It is recognized that ride quality in itself does not fully represent vehicle tolerance to stresses and motions.

20. Absorbed power as a ride severity criterion was established through laboratory tests at the U. S. Army Tank-Automotive Research and Development Command (TARADCOM) several years ago. Six watts of absorbed power was established as a reasonable standard human tolerance limit when vibration was in the vertical direction only. While results of field tests indicate that a driver will often subject himself to 10-15 w for short periods of time, he will not willingly subject himself to more than 6 w for more than about 30 min at a time; severe fatigue could result from higher exposure. Accordingly, the vehicle speed at 6-w AP_{vt} is currently the limiting speed criterion used for describing ride quality and is the ride quality criterion used in the AMM and presented in the analysis. The 6-w limit at the driver's seat generally appears to be the most critical in determining ride performance and was used in

the field tests to determine vehicle speeds required to develop the ride quality curves regardless of the measurement point on the vehicle.

21. Measured acceleration response data and corresponding vehicle speeds were plotted as ride response data in the plates. Relations were delineated by faired curves through the data points to show the manner in which the ride and cargo responses change with speed for each test vehicle on each ride course. The vehicle speeds corresponding to 6-w AP_{vt} were obtained from the plots and, along with the measured course surface roughness, are shown in the plates. Faired curves were drawn through the data points to construct ride performance curves for each vehicle configuration.

Analysis of Field Test Results and Vehicle Rankings

FAMECE ride performance

22. One aspect of this study was to compare the ride quality of the FAMECE at several points on the vehicle that could be occupied by military troops while the FAMECE dumper was in service as a troop carrier. The summary ride performance data for the standard FAMECE dumper configuration (55-psi tire pressure, empty, and seat under pressure), as shown in Plates 1, 19, 34, 48, and 64, were used to construct the curves plotted in Figure 4. As noted in the figure, the poorest ride performance, as expected, occurred at the rear center of the cargo bed for the vehicle conditions shown. However, the next poorest ride point was the driver's station while the seat was under 100 psi of pressure. Although pressurized seats appear to reduce driver fatigue over lengthy driving trips on paved roads when surface roughness is minimal, the seats offer little assistance for short-duration driving over difficult terrain such as that used in the tests. The other three measurement points exhibited similar ride performance, all three being slightly better than either the driver's station or rear-center cargo. For comparison, the same five-measurement-point data were extracted from curves in Plates 3, 20, 35, 51, and 66 (empty) and Plates 8, 25, 40, 55, and 70 (loaded) for the FAMECE dumper at 55 psi, but with the seat

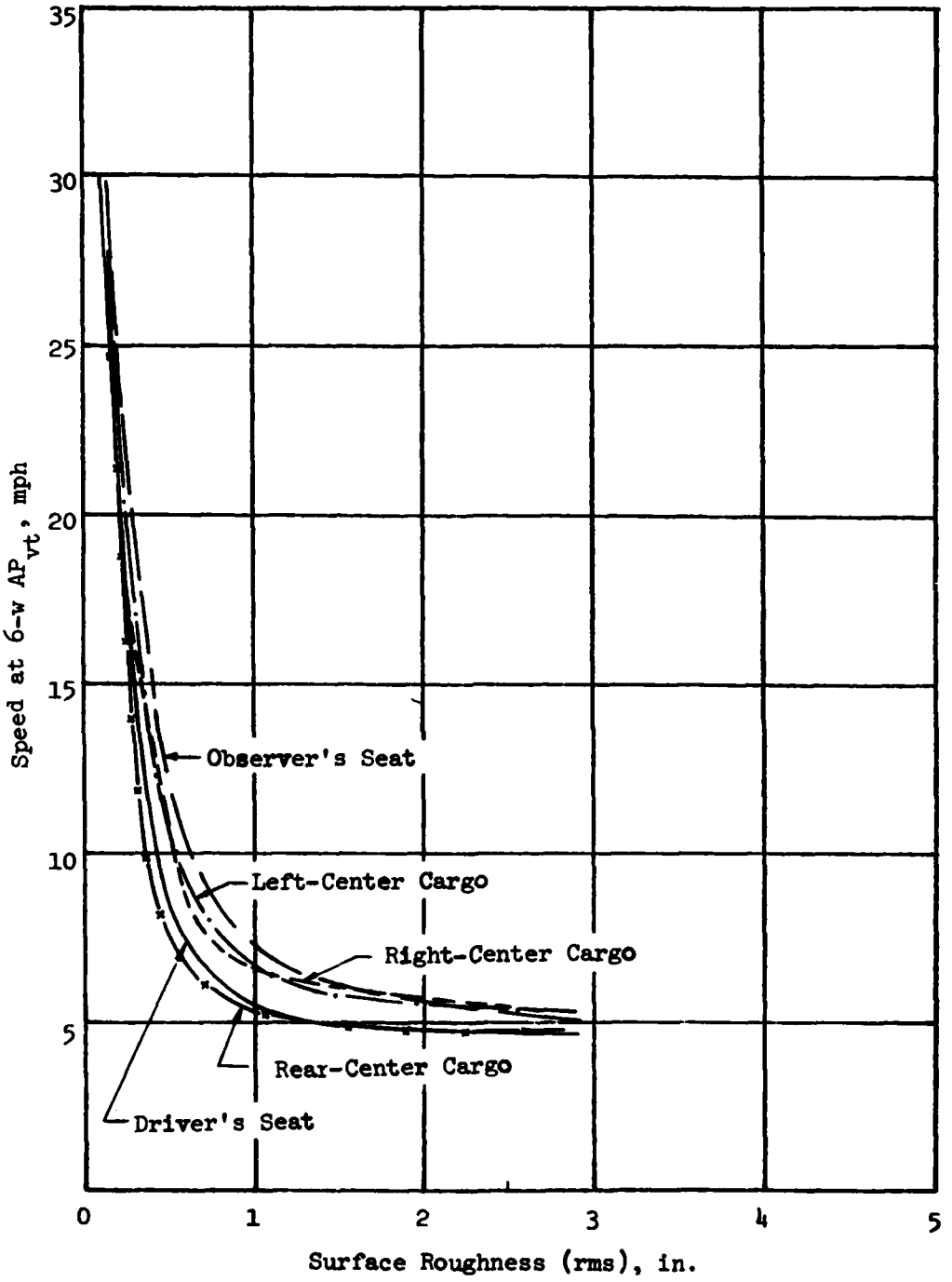


Figure 4. Ride performance at five measured response points for FAMECE dumper - empty, 55-psi tire pressure, and driver's seat under 100-psi pressure

blocked (no suspended seat effects) in the empty and loaded conditions, and plotted together in Figures 5 and 6. Although no large differences were evident for the various measurement points, the rear-center cargo area again produced the poorest ride performance for both configurations. The ride performance at the driver's station was much better with the seat blocked (Figure 5), and even better with the seat blocked and the vehicle loaded (Figure 6). To determine the effects of the loading and driver's seat configurations on driver response, the data for the vertical response at the driver's station for the various FAMECE dumper test conditions from Plates 1, 3, 5, 8, and 10 are plotted in Figure 7. As noted in the figure, the poorest ride performance for the driver occurs in the standard FAMECE dumper configuration, i.e., empty, 55-psi tire pressure, and driver's seat under 100-psi tire pressure. Although only one test was conducted with the vehicle configuration, loaded, 45-psi tire pressure, and driver's seat blocked, the test indicated that the ride performance for the driver would be much better for this condition than that at the normal operating condition, or at any of the conditions tested.

23. Based on the data shown in Figures 4-5, the ride performance for troops riding in the cargo bed would vary depending on their seating location in the bed. Little differences are evident in Figure 4 between the left- and the right-center cargo performance, but the rear-center cargo exhibited the poorest ride performance of all five measurement points. The front of the cargo bed, nearest the center of gravity, should provide a better ride performance than either the left- or the right-center cargo or the rear-center cargo, although the measured data for the front cargo area were not included in the analysis. An average ride performance for the cargo bed, however, should be exhibited by the left- or the right-center cargo. The ride performance for the left- and right-center cargoes for both the FAMECE dumper, at 55- and 45-psi tire pressures, and the M51, 5-ton dump truck, at 35-psi tire pressure, are presented in Figure 8; the plotted data were extracted from Plates 35, 37, 44, 50, 52, and 59. As noted in the figure, the M51, 5-ton cargo bed, exhibited a

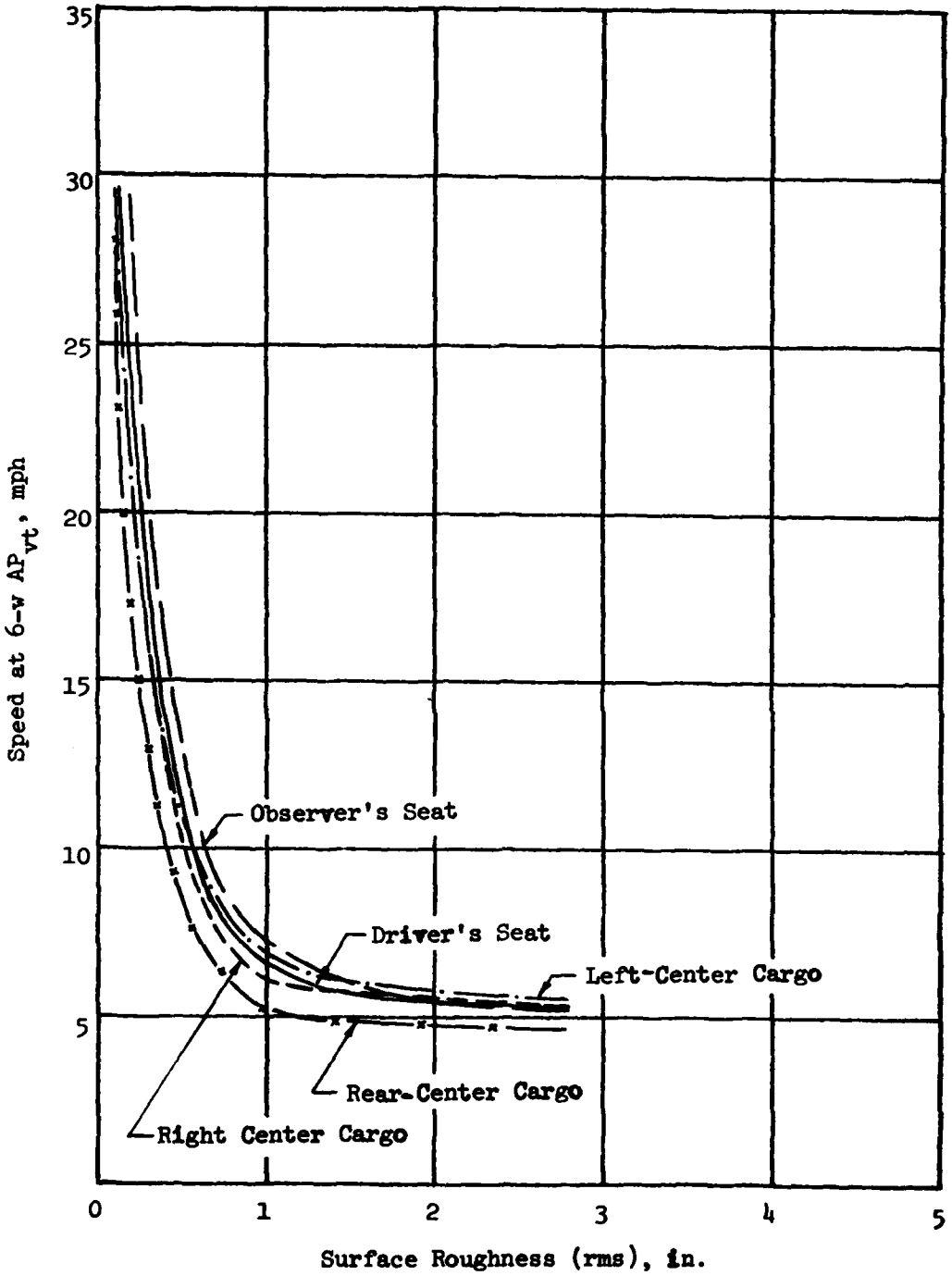


Figure 5. Ride performance at five measured response points for FAMECE dumper - empty, 55-psi tire pressure, and driver's seat blocked

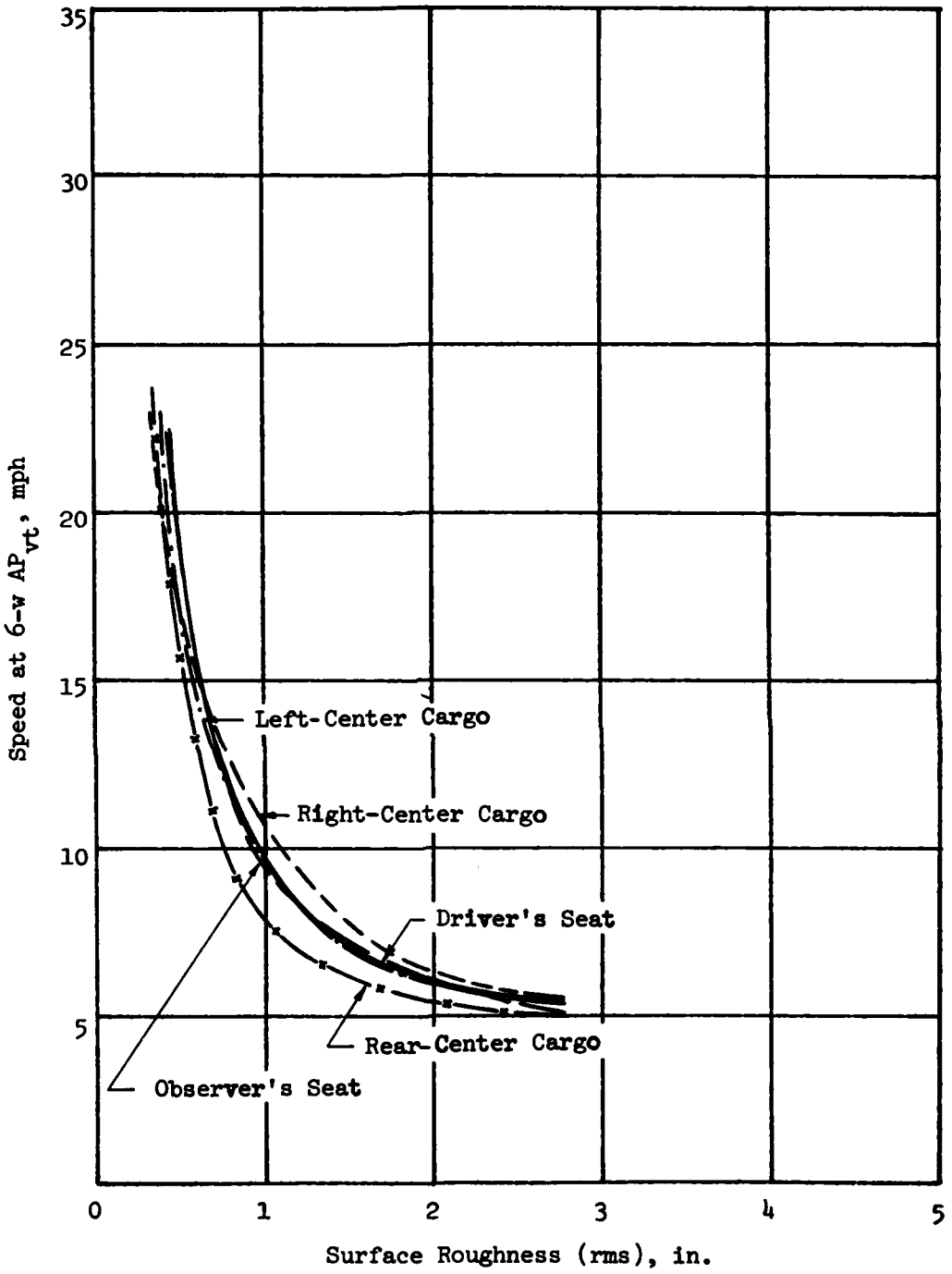


Figure 6. Ride performance at five measured response points for FAMECE dumper - loaded, 55-psi tire pressure, and driver's seat blocked

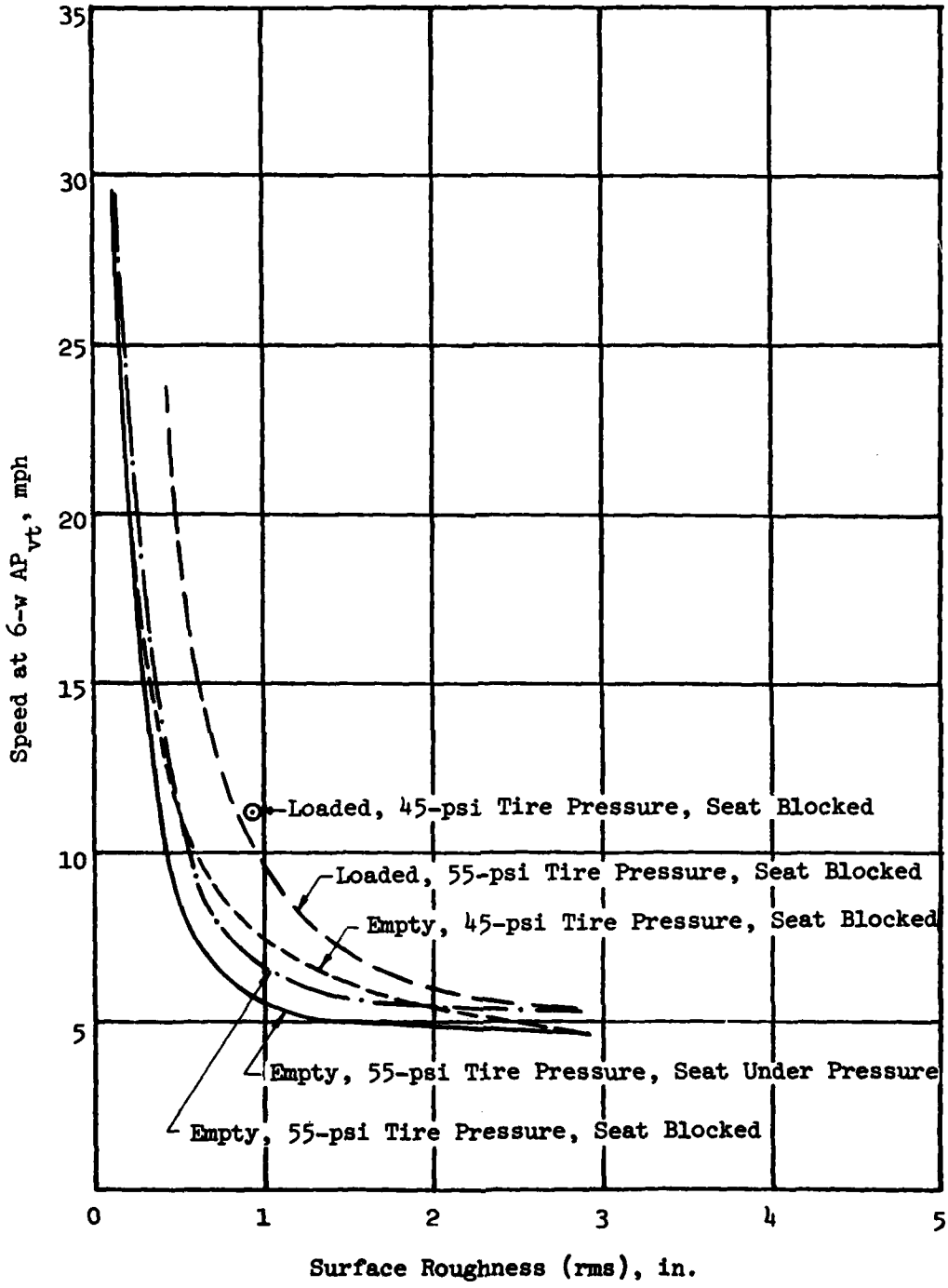


Figure 7. Ride performance at driver's seat for FAMECE dumper at various test configurations

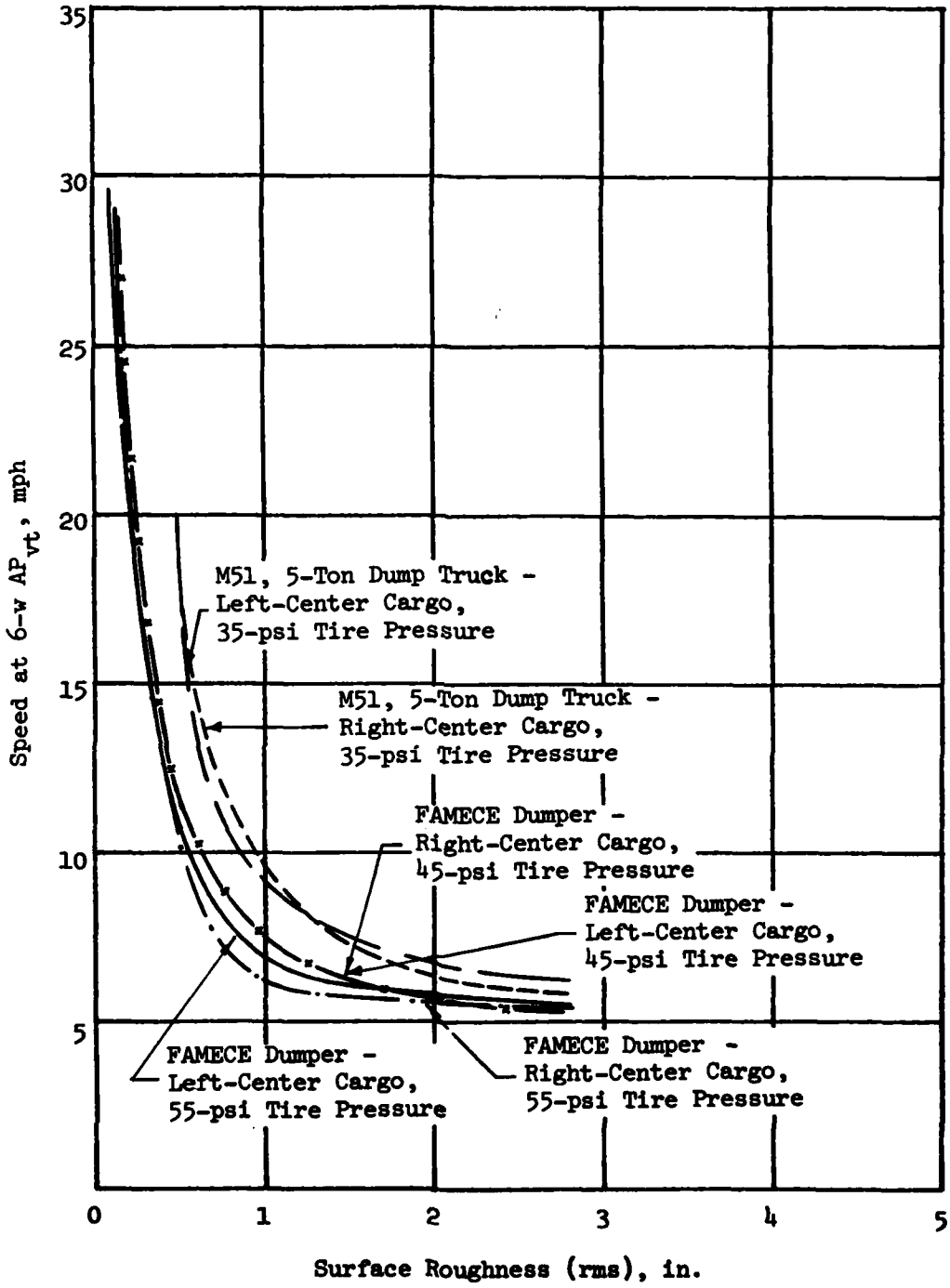


Figure 8. Left- and right-center cargo ride performance of the FAMECE dumper - empty, driver's seat blocked, and 55- and 45-psi tire pressures; and M51, 5-ton dump truck, - empty and 35-psi tire pressure

better ride performance than the FAMECE cargo bed at either the 55- or the 45-psi tire pressure.

M51, 5-ton dump truck, ride performance

24. The ride performance data for the five measured response points on the M51, 5-ton dump truck, extracted from Plates 12, 29, 44, 59, and 74 for the vehicle empty, are shown in Figure 9. As noted in the figure, the driver and the left- and right-center cargo area performance curves are better than either the observer's ride performance or the rear-center cargo ride performance. Over the terrain roughness used for the tests, the driver's ride performance was generally slightly better than the other four measured ride performance points on the vehicle.

25. In the comparison of ride performance empty and loaded, the vertical ride performance at the driver's station (the best of the five points as described previously) was extracted from Plates 12 and 14 and plotted in Figure 10. As noted in the figure, the ride performance at the driver's station was slightly better (or about the same) for the loaded configuration at the same tire pressure of 35 psi.

Comparison of ride performance, driver's station

26. As a method of comparing similar performance criteria (JD544A loader has no "cargo" area similar to the dump trucks), the ride performance data for the three test vehicles, empty and at the driver's station, were extracted from Plates 1, 3, 12, and 16 and plotted in Figure 11. As noted in the figure, the M51, 5-ton dump truck, ride performance was much better than either the FAMECE dumper or the JD544A loader, which were about the same, although the ride performance of the FAMECE dumper with the driver's seat under pressure was actually slightly worse than that of the loader.

Summary

27. The following assessment summarizes the test results:

a. The ride performance at the driver's station of the FAMECE dumper was somewhat better without the seat pressurized than with the seat under 100-psi pressure, and

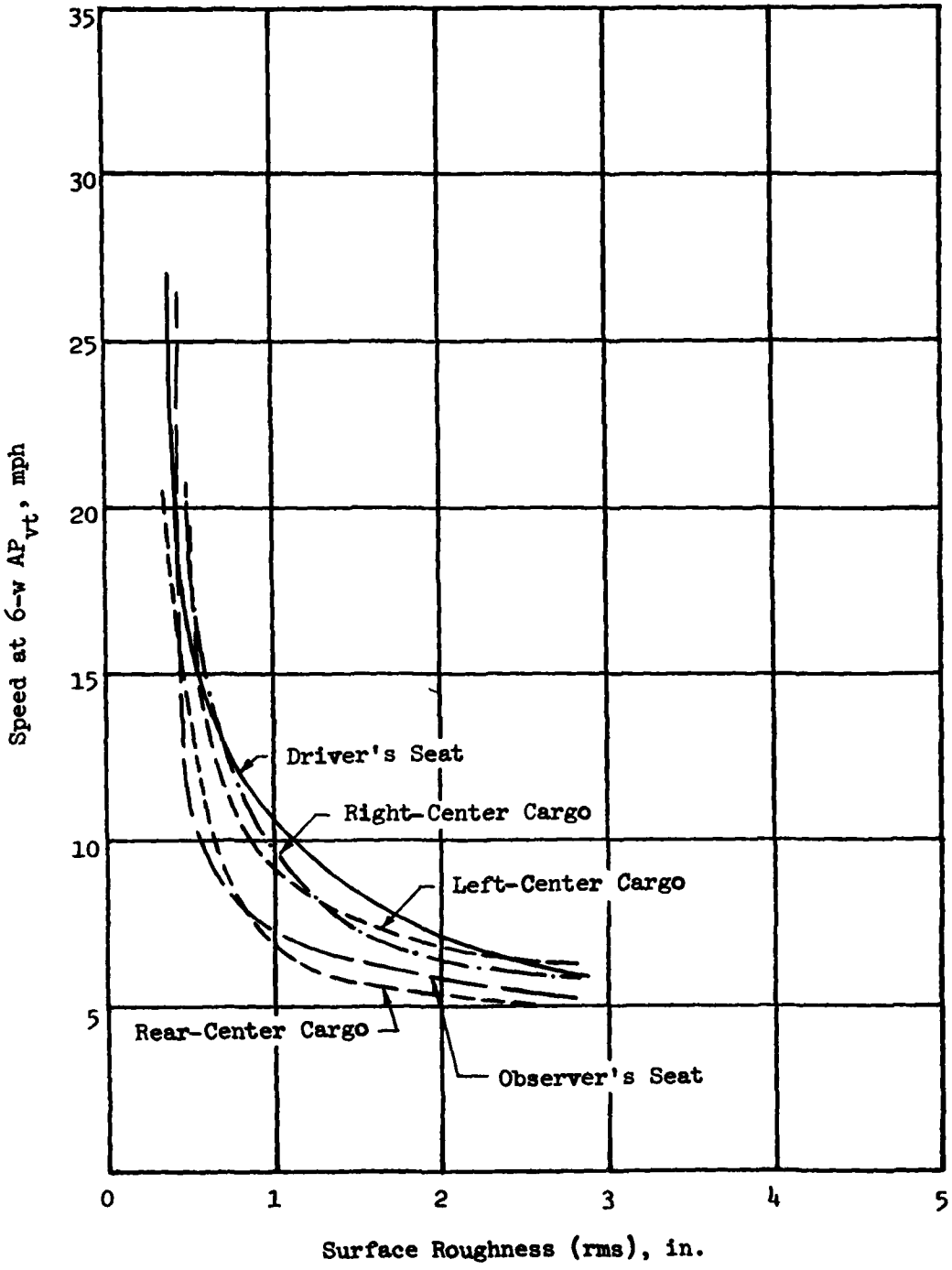


Figure 9. Ride performance at five measured response points for M51, 5-ton dump truck - empty and 35-psi tire pressure

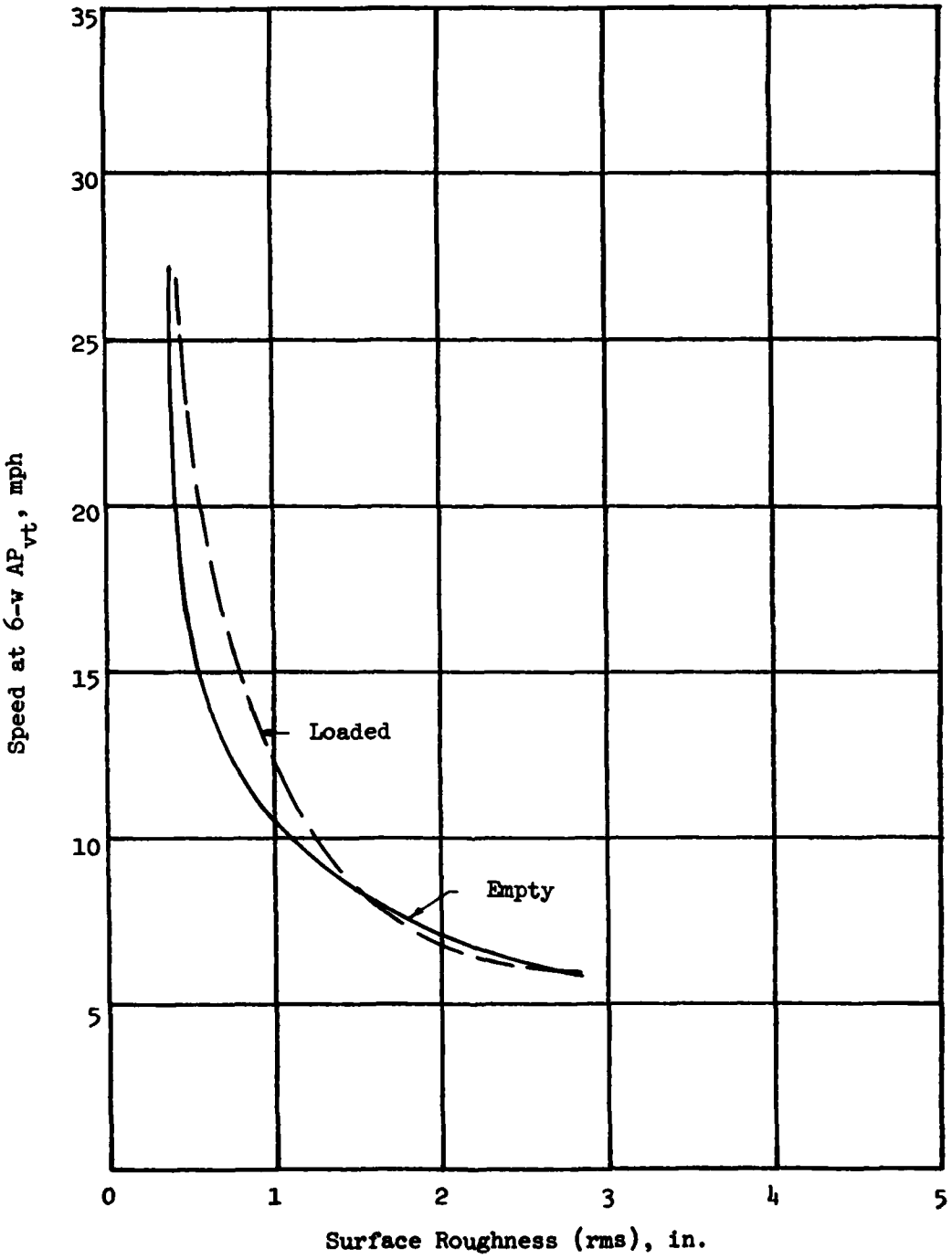


Figure 10. Ride performance at driver's seat for M51, 5-ton dump truck - empty, loaded, and 35-psi tire pressure

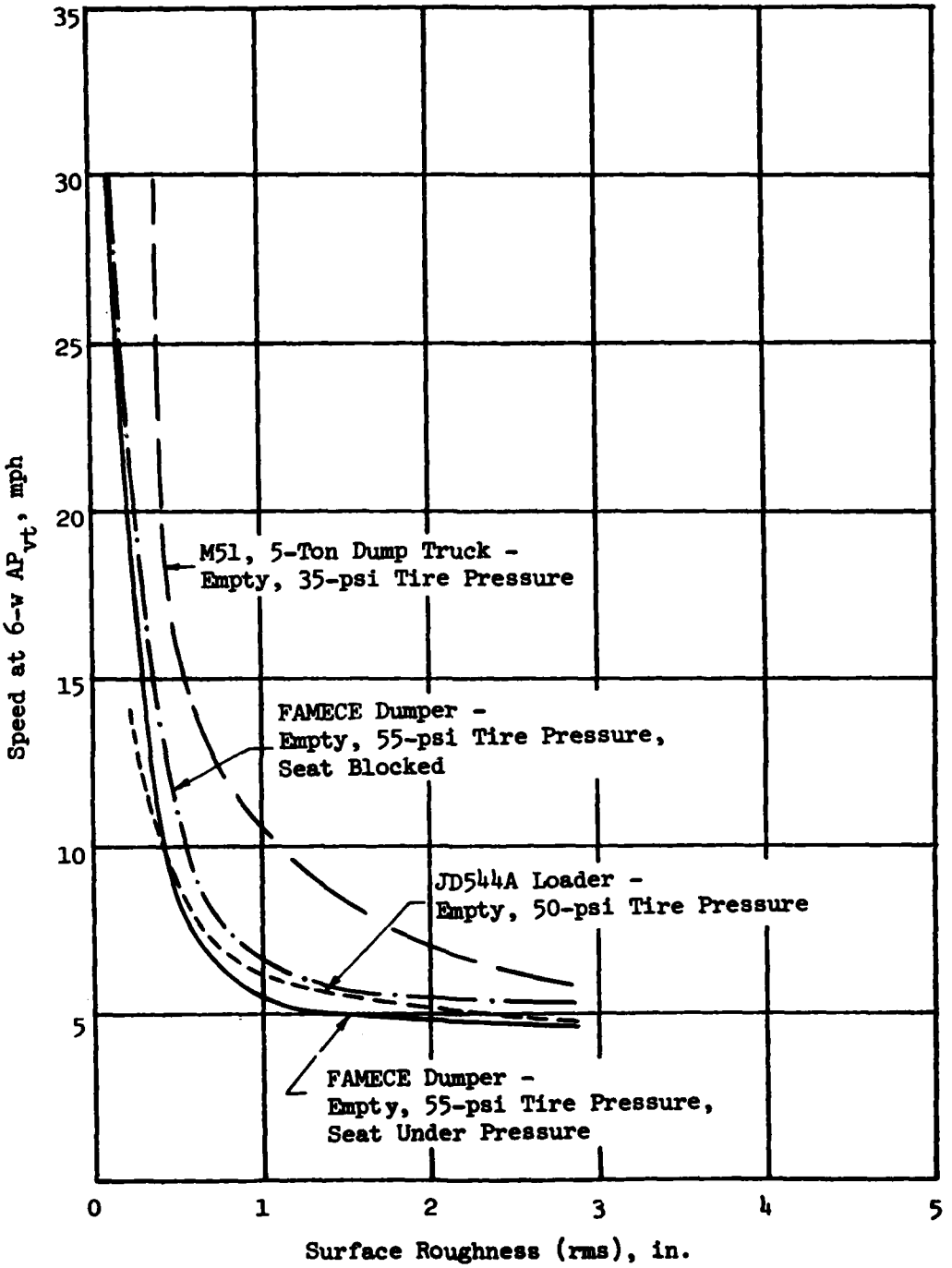


Figure 11. Ride performance at the driver's seat for FAMECE dumper - empty, and 55-psi tire pressure; M51, 5-ton dump truck - empty, and 35-psi tire pressure; and JD544A loader - empty and 50-psi tire pressure

the best ride performance was obtained by the driver with the FAMECE configuration, loaded, 45-psi tire pressure, and seat not pressurized.

b. The poorest ride performance of the five measurement points on the FAMECE dumper at all loading configurations was obtained at the rear center of the cargo area.

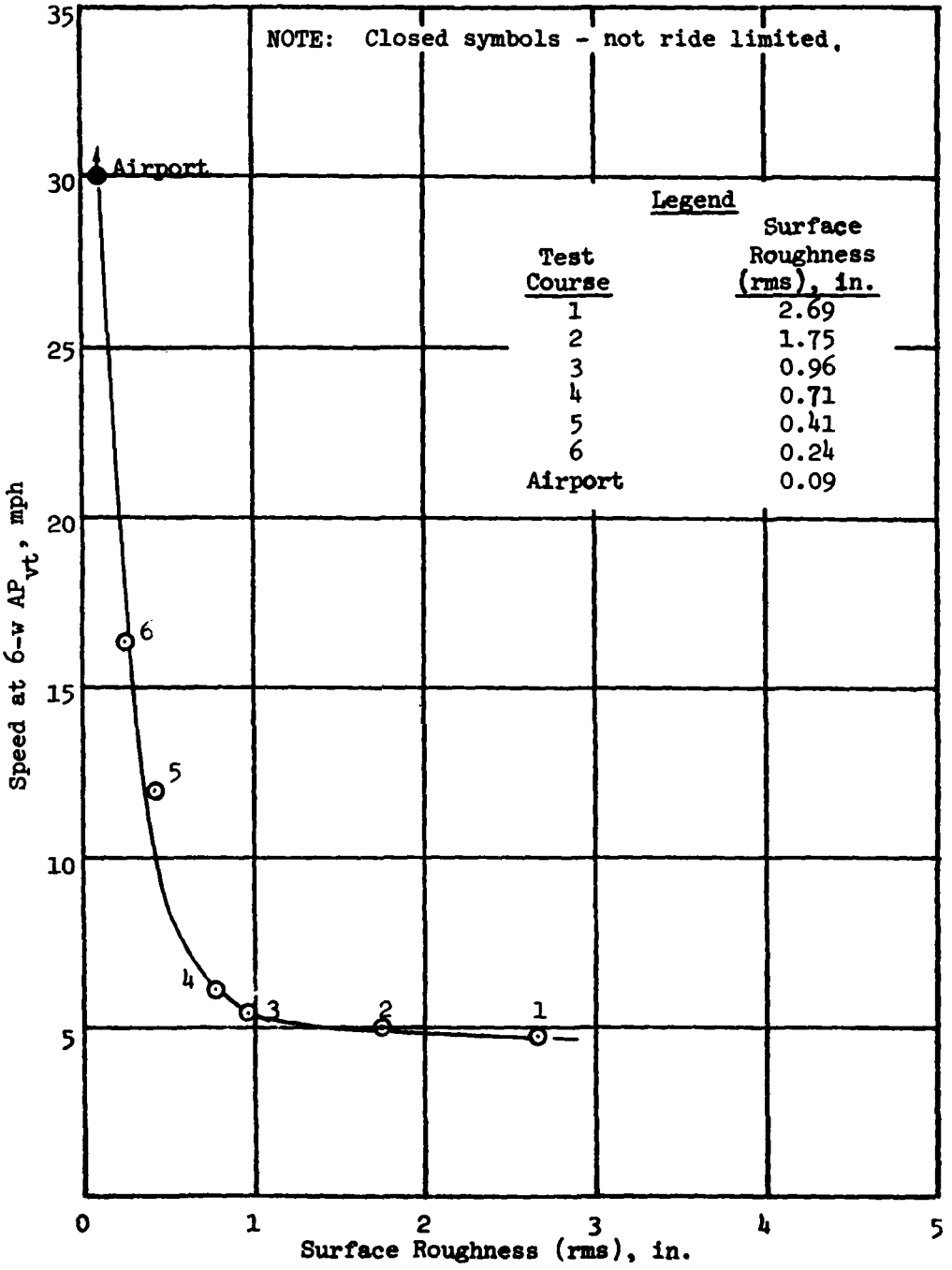
c. The ride performance as a troop carrier (in the cargo area) for the M51, 5-ton dump truck, at 35-psi tire presure was slightly better than for the FAMECE dumper at both the 55- and the 45-psi tire pressure.

d. The ride performance of the M51, 5-ton dump truck, at the driver's station was slightly better than for the other four measurement points on the vehicle.

e. The ride performance at the driver's station for the vehicles, empty, was best for the M51, 5-ton dump truck, followed by the FAMECE dumper and JD544A loader, which were about the same.

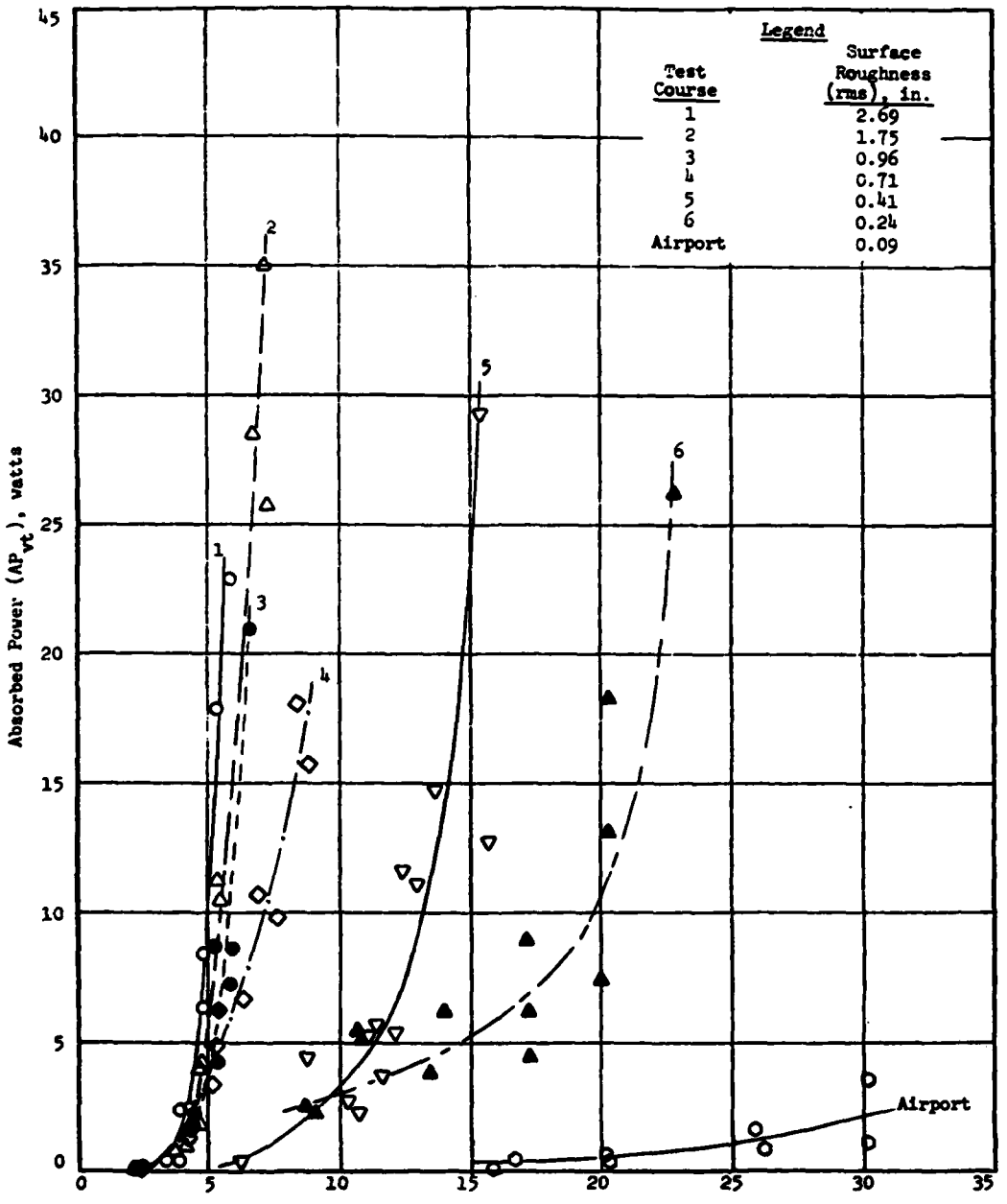
Table 1
General Characteristics of Study Vehicles

Vehicle	Gross Vehicle Weight, lb		Tire Size	Recommended Cross-Country Inflation Pressure, psi	Approximate Maximum Speed, mph
	Empty	Loaded			
FAMECE dumper	28,160	51,160	23-21, 20 ply	55	30
M51, 5-ton dump truck	22,170	32,455	11.00-20 NDCC	35	50
John Deere (JD544A) front-end loader	18,380	--	14.00-24, 16 ply	50	20



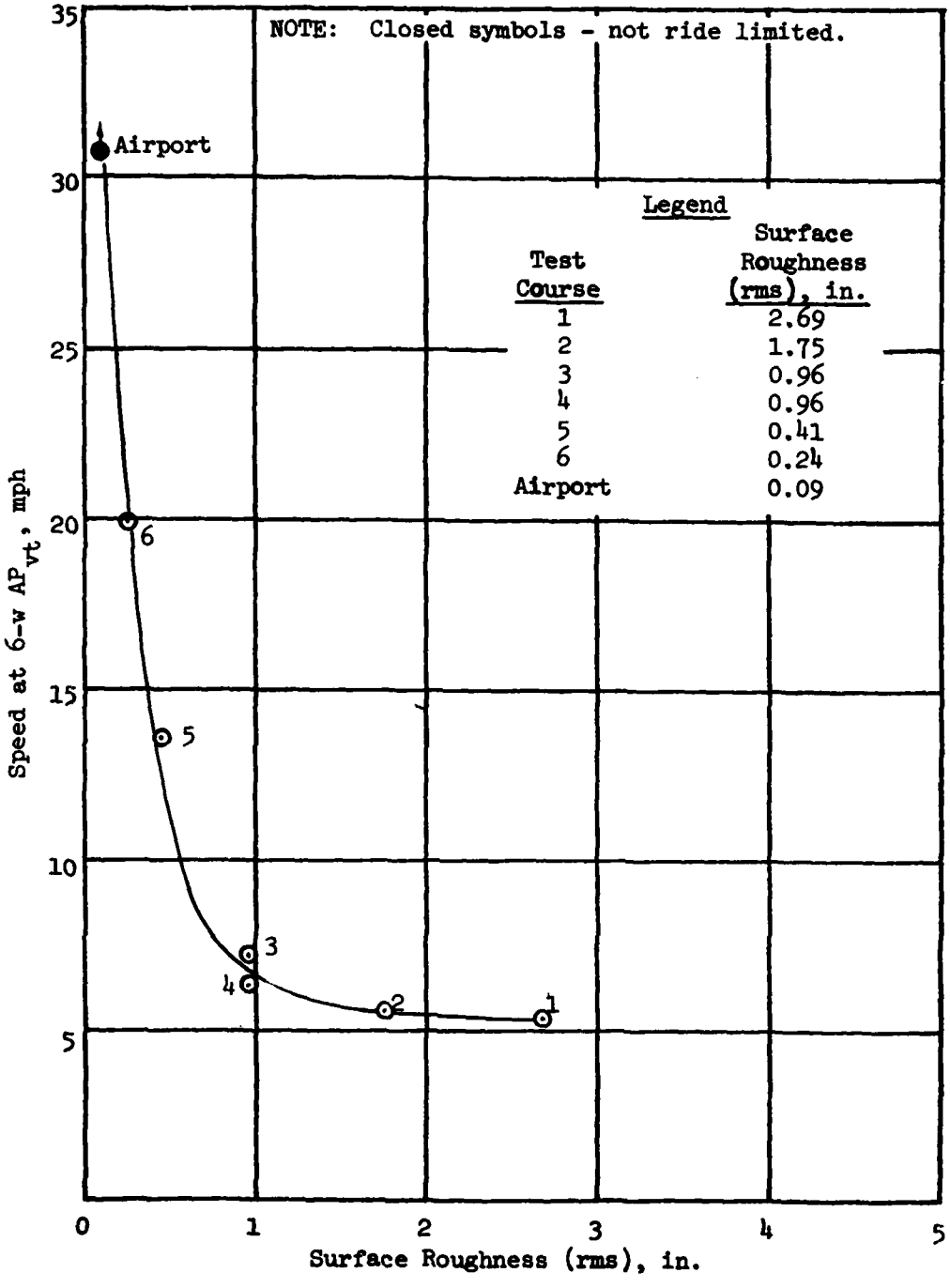
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, EMPTY
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 1



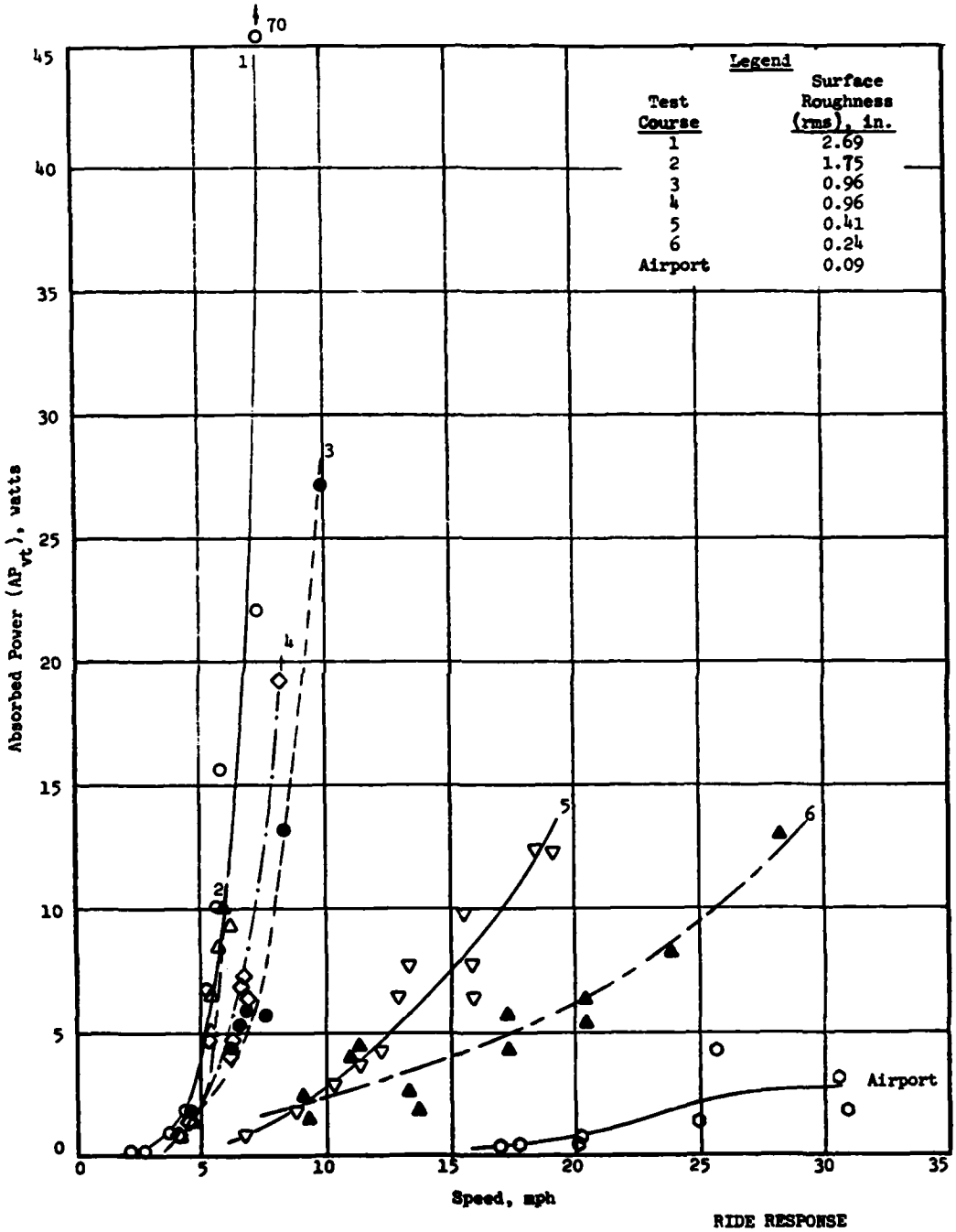
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, EMPTY
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 2



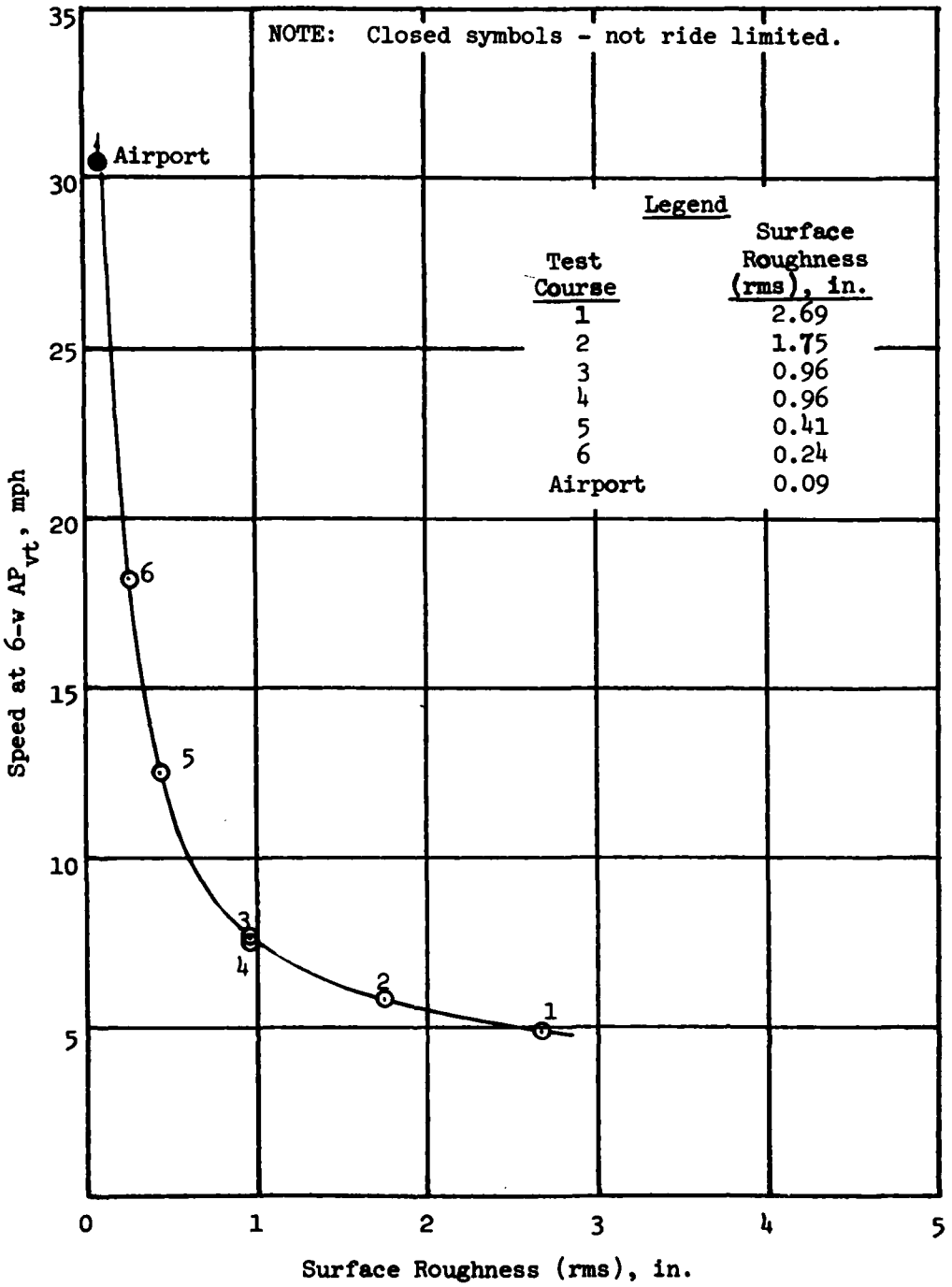
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, EMPTY
55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 3



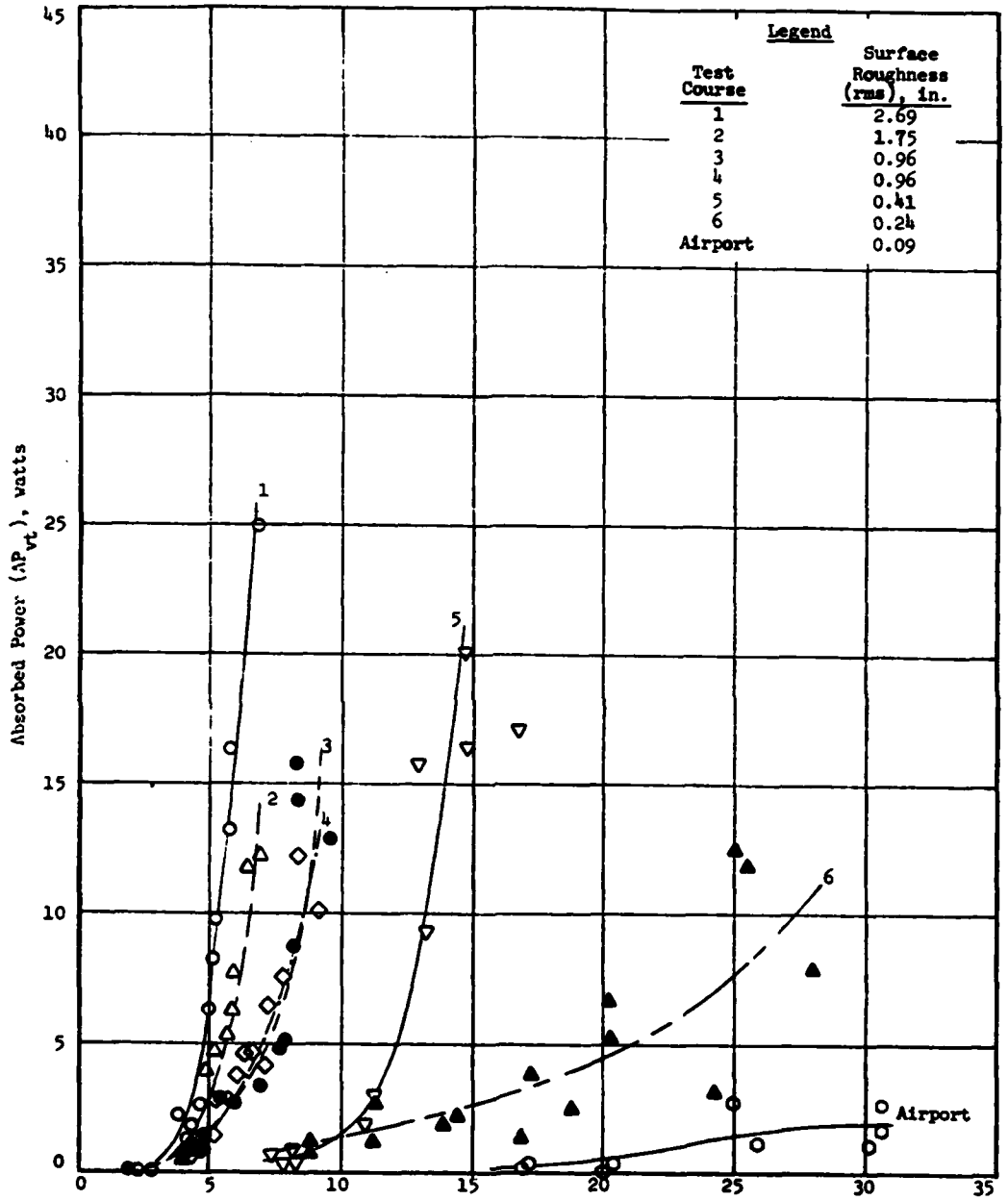
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, EMPTY
55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 4



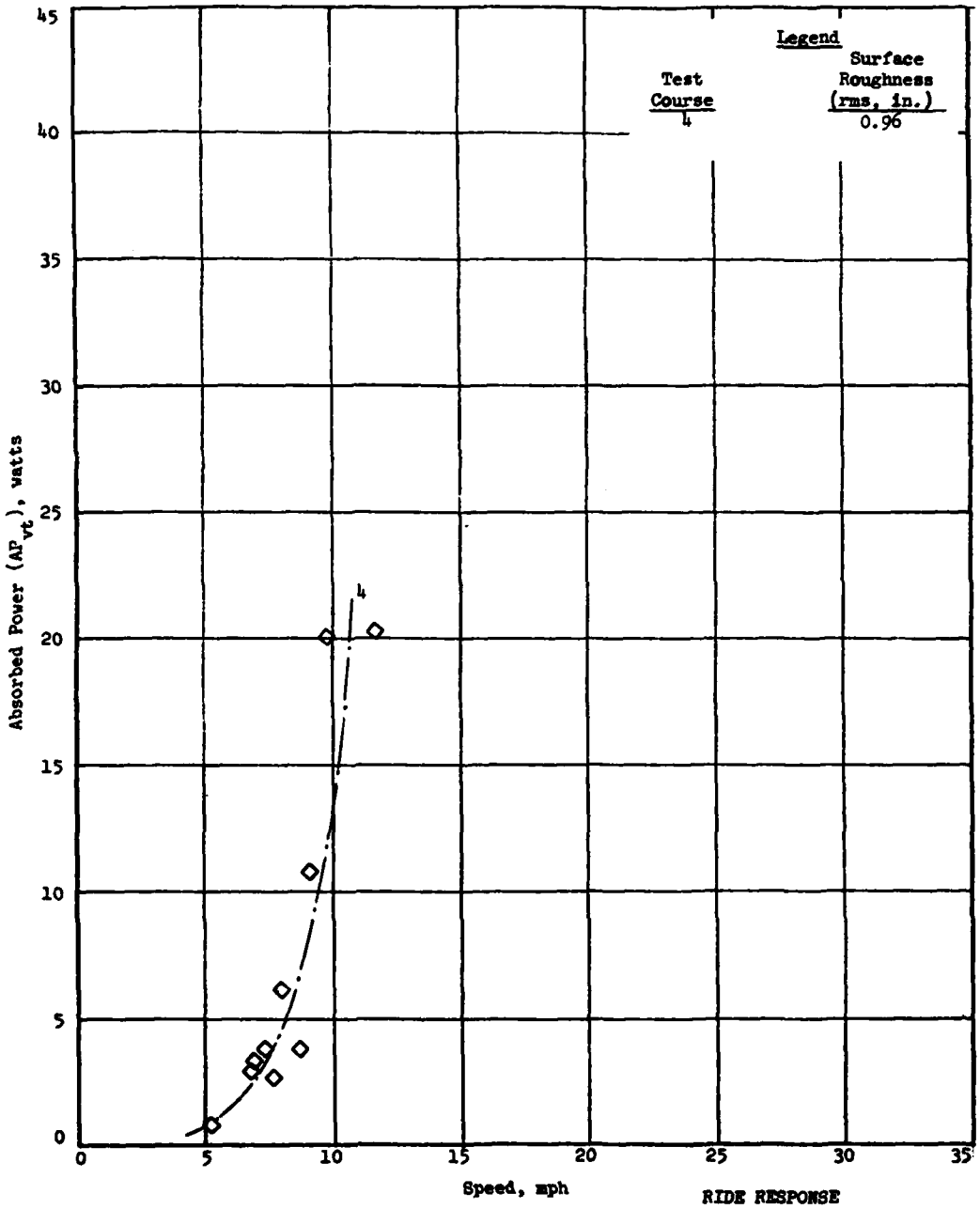
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, EMPTY
45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 5



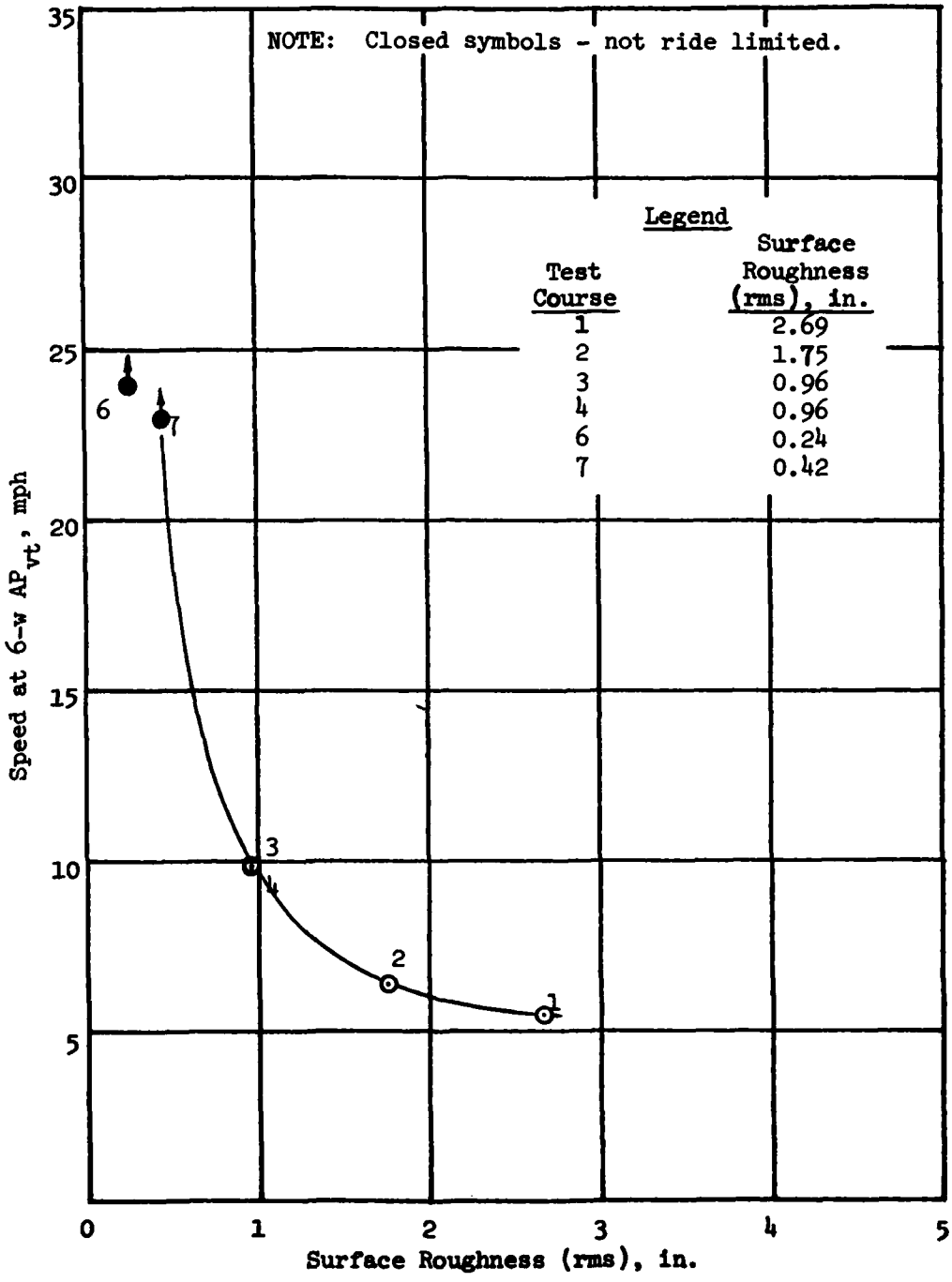
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, EMPTY
45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 6



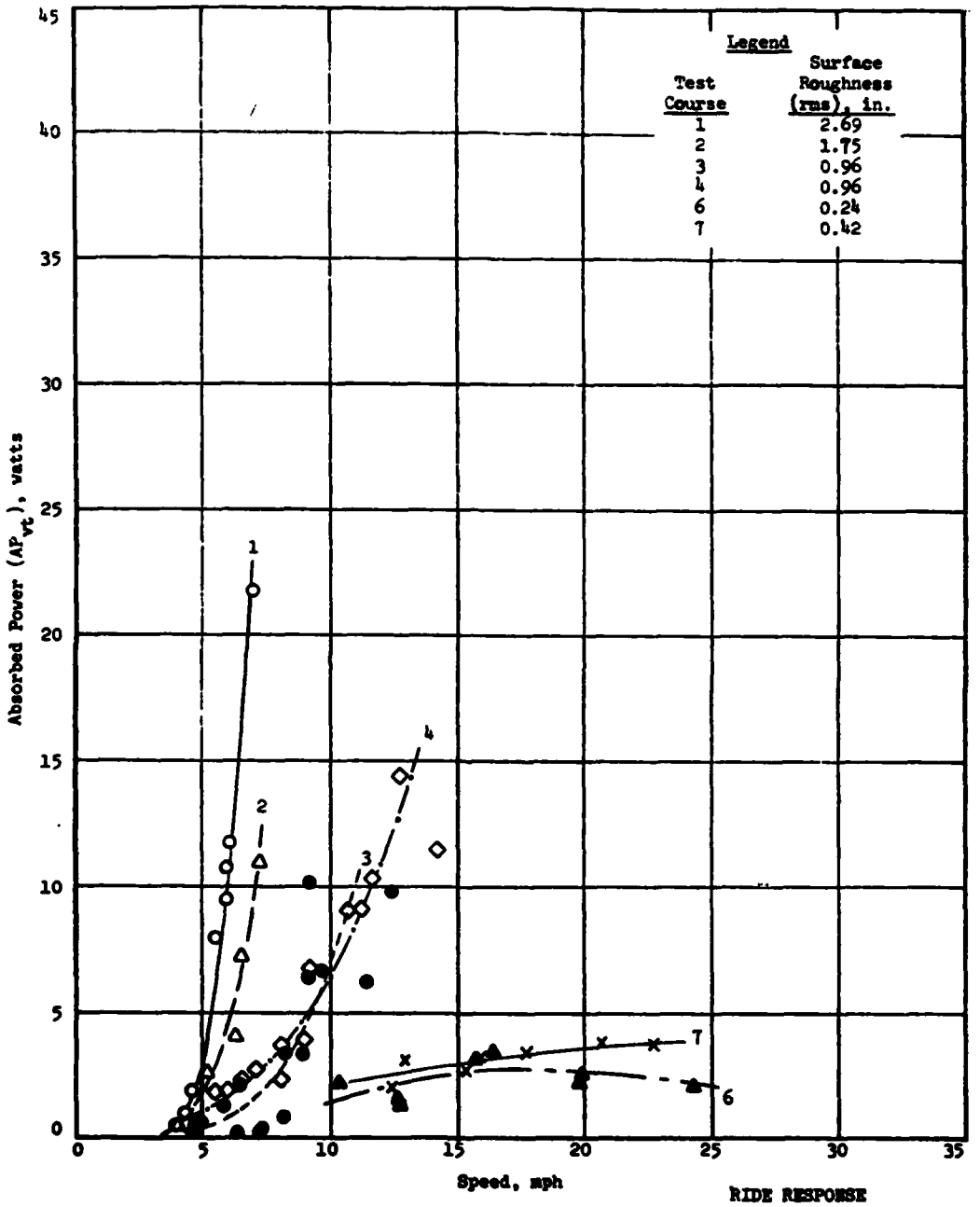
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, LOADED
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 7



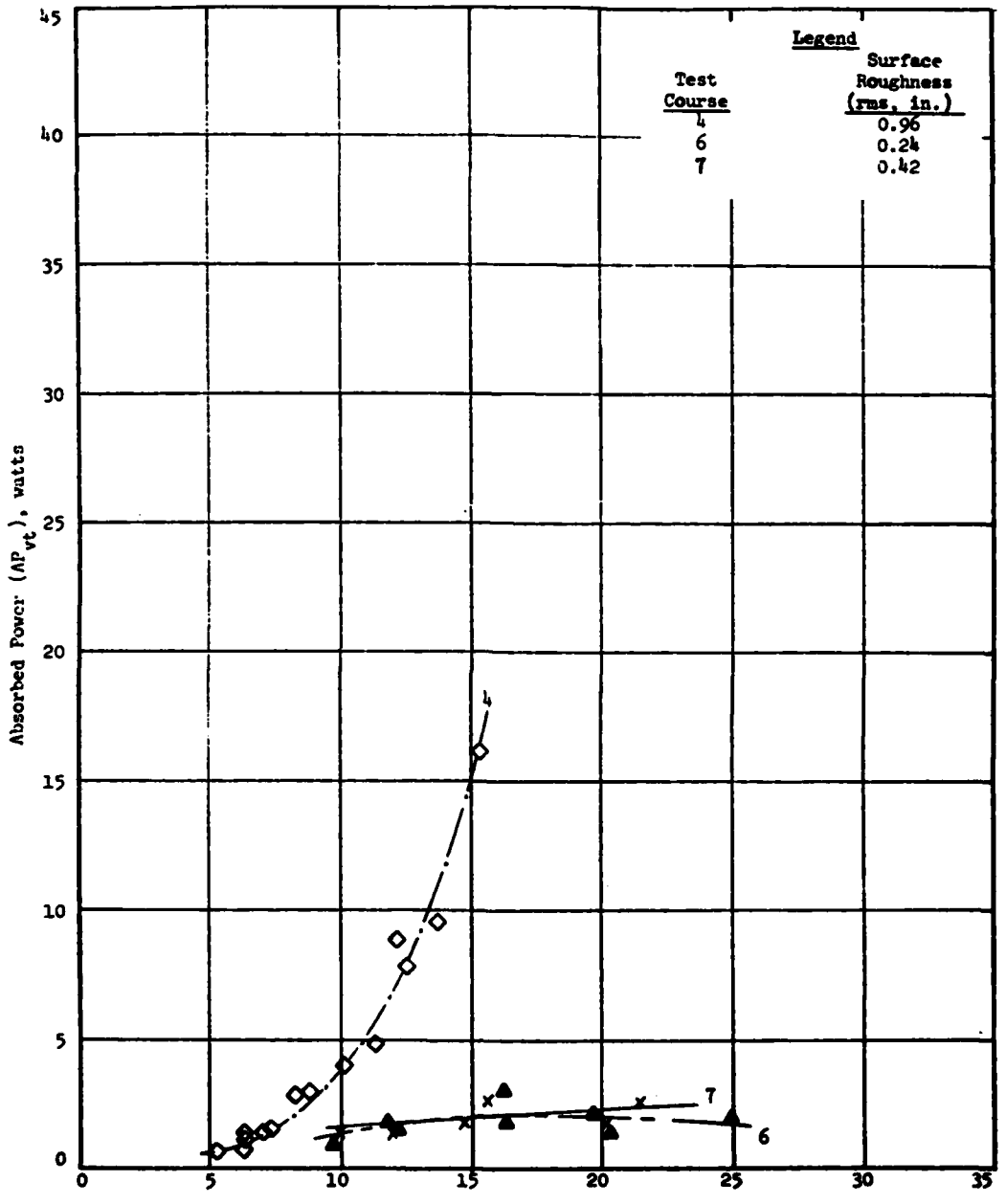
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, LOADED
55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 8



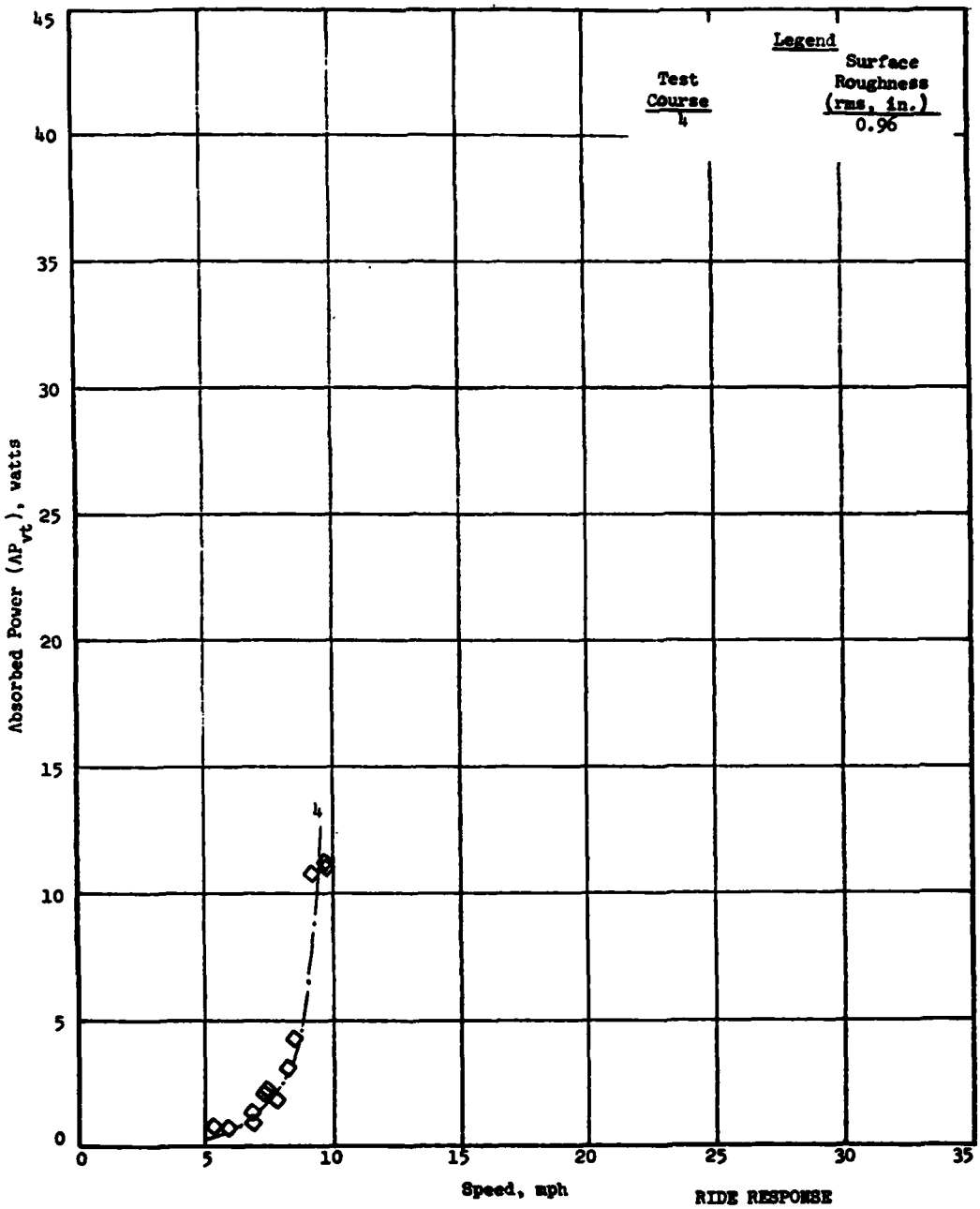
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, LOADED
55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 9



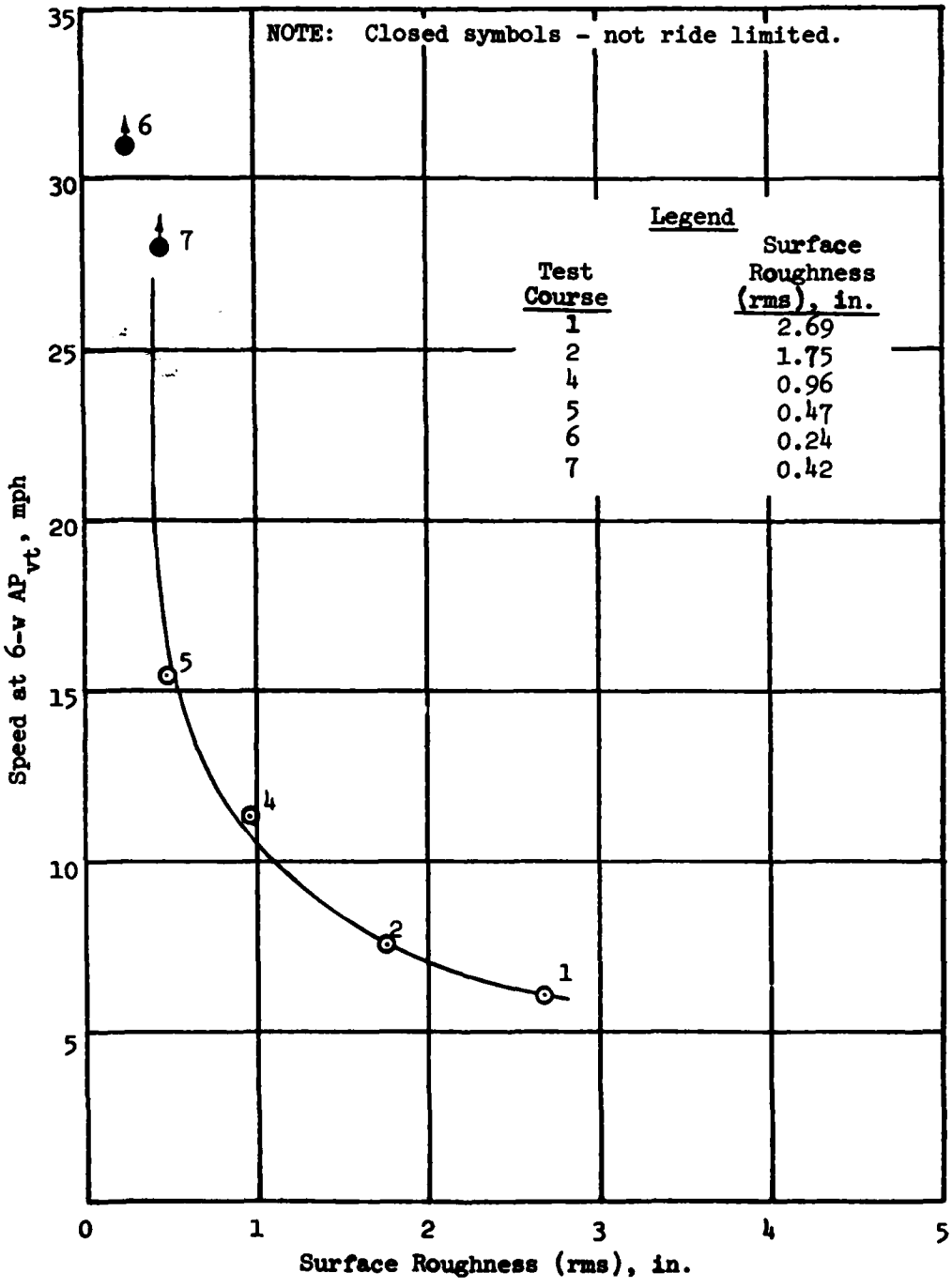
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, LOADED
45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 10



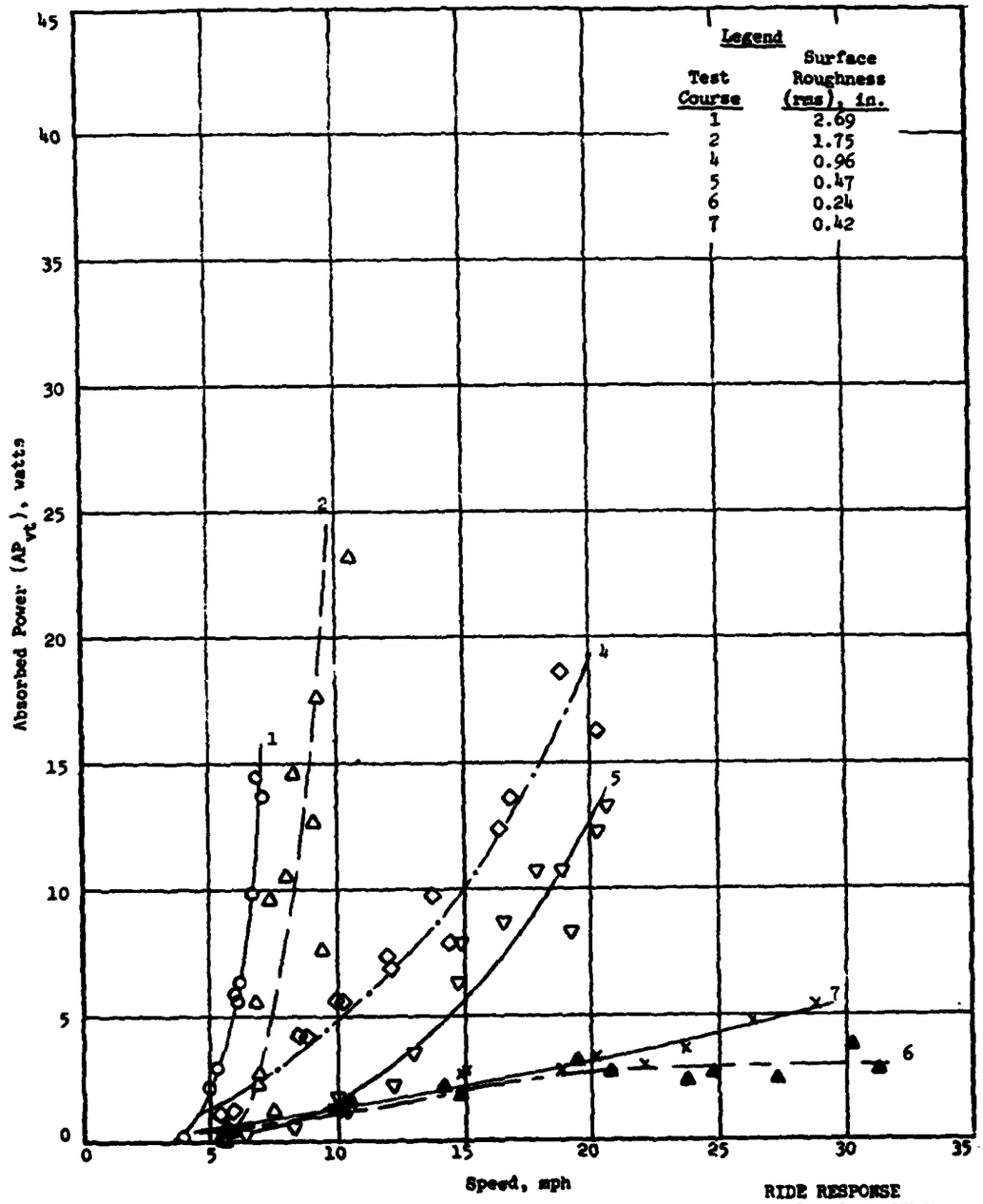
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, DRIVER'S STATION, LOADED
45-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 11



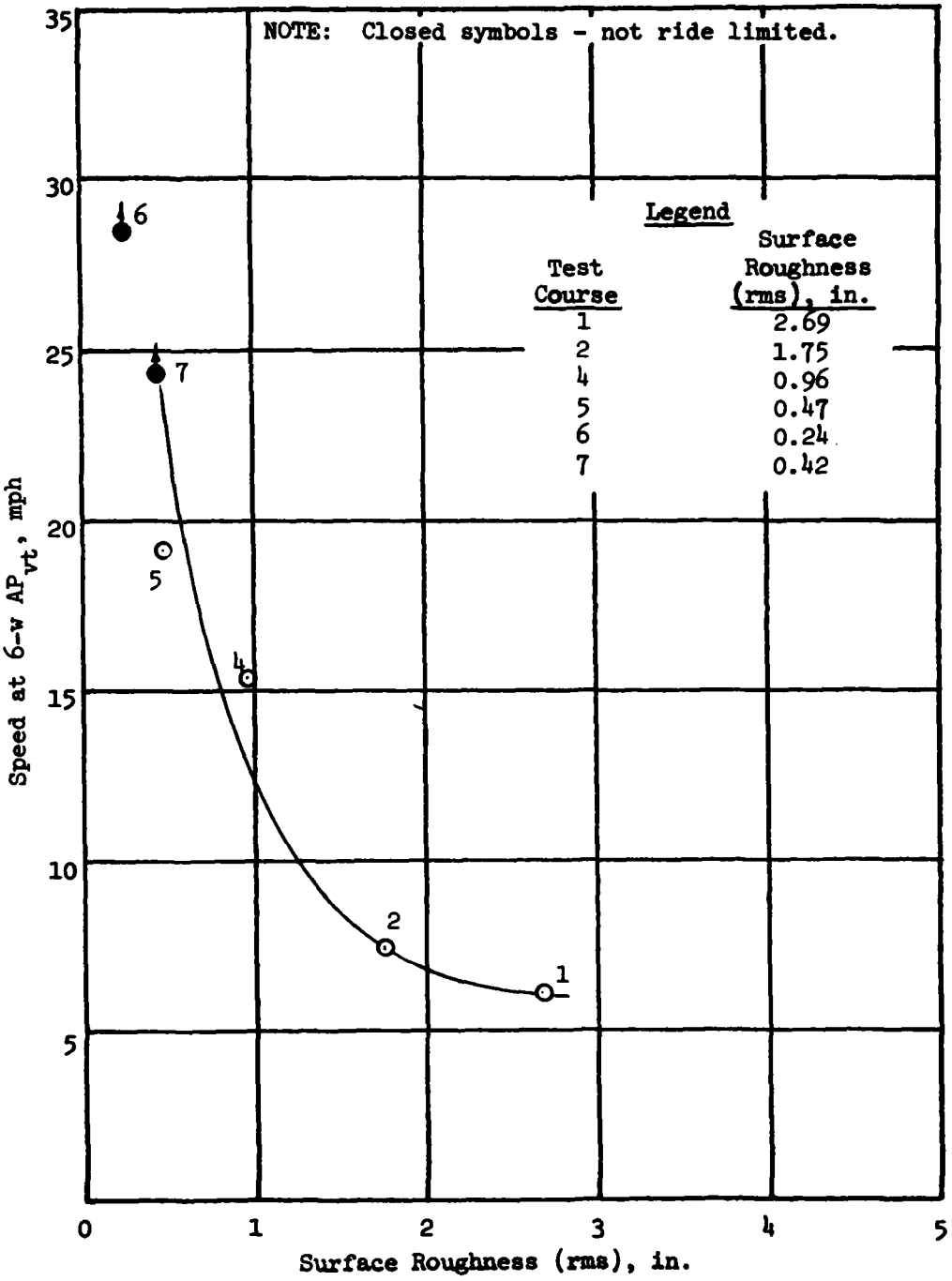
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, DRIVER'S STATION
EMPTY, 35-PSI TIRE PRESSURE

PLATE 12



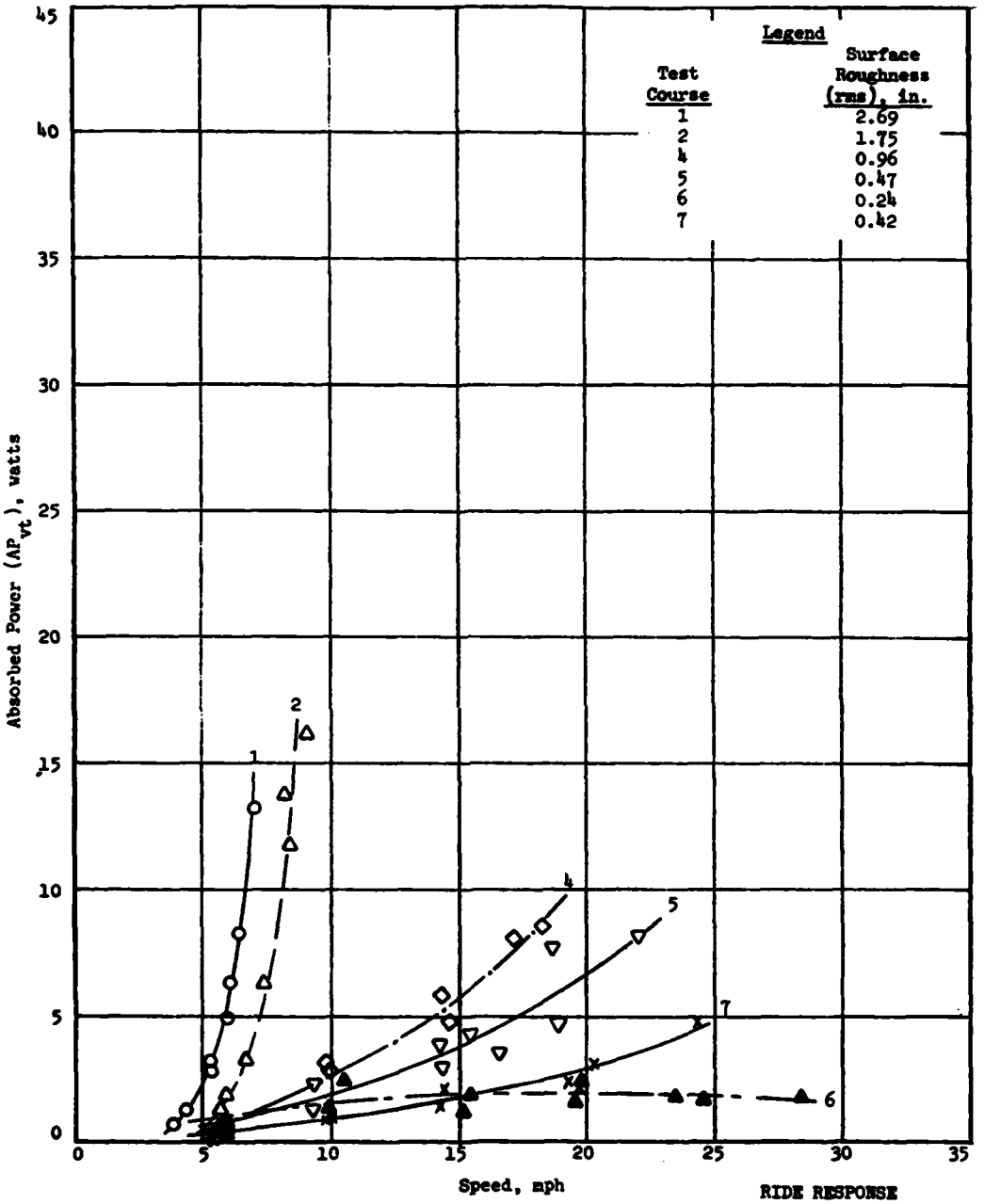
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, DRIVER'S STATION
EMPTY, 35-PSI TIRE PRESSURE

PLATE 13



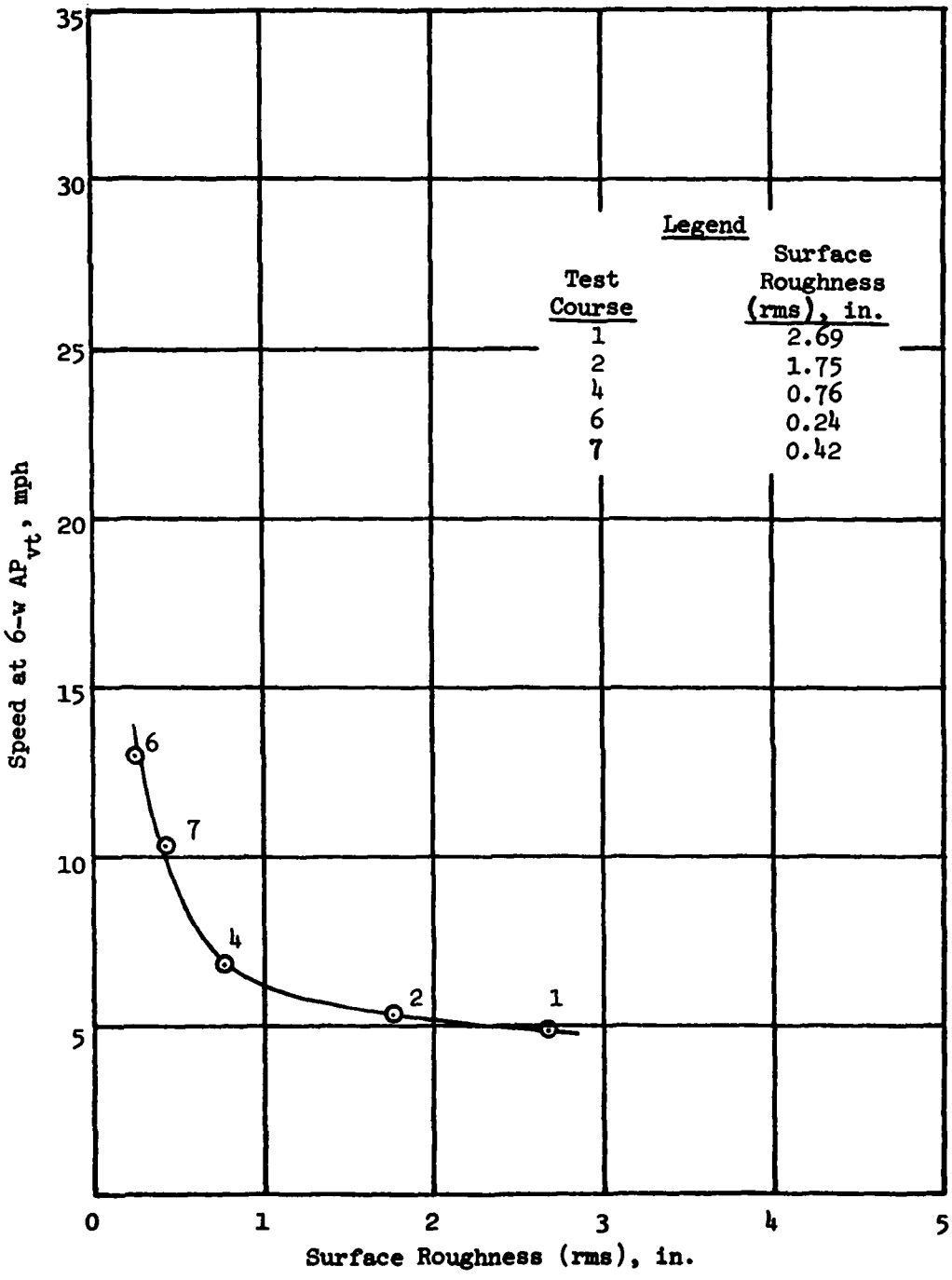
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, DRIVER'S STATION
LOADED, 35-PSI TIRE PRESSURE

PLATE 14



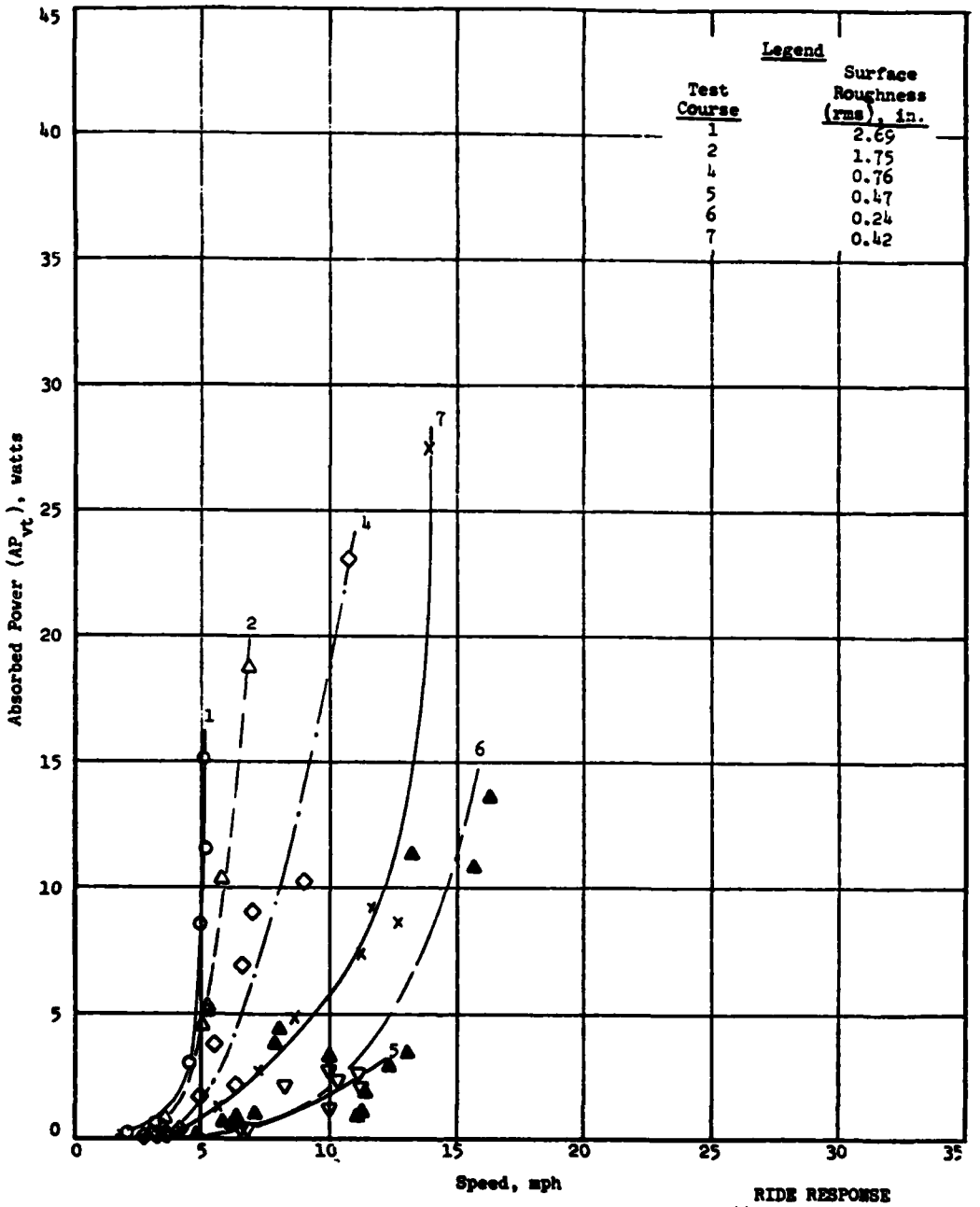
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, DRIVER'S STATION
LOADED, 35-PSI TIRE PRESSURE

PLATE 15



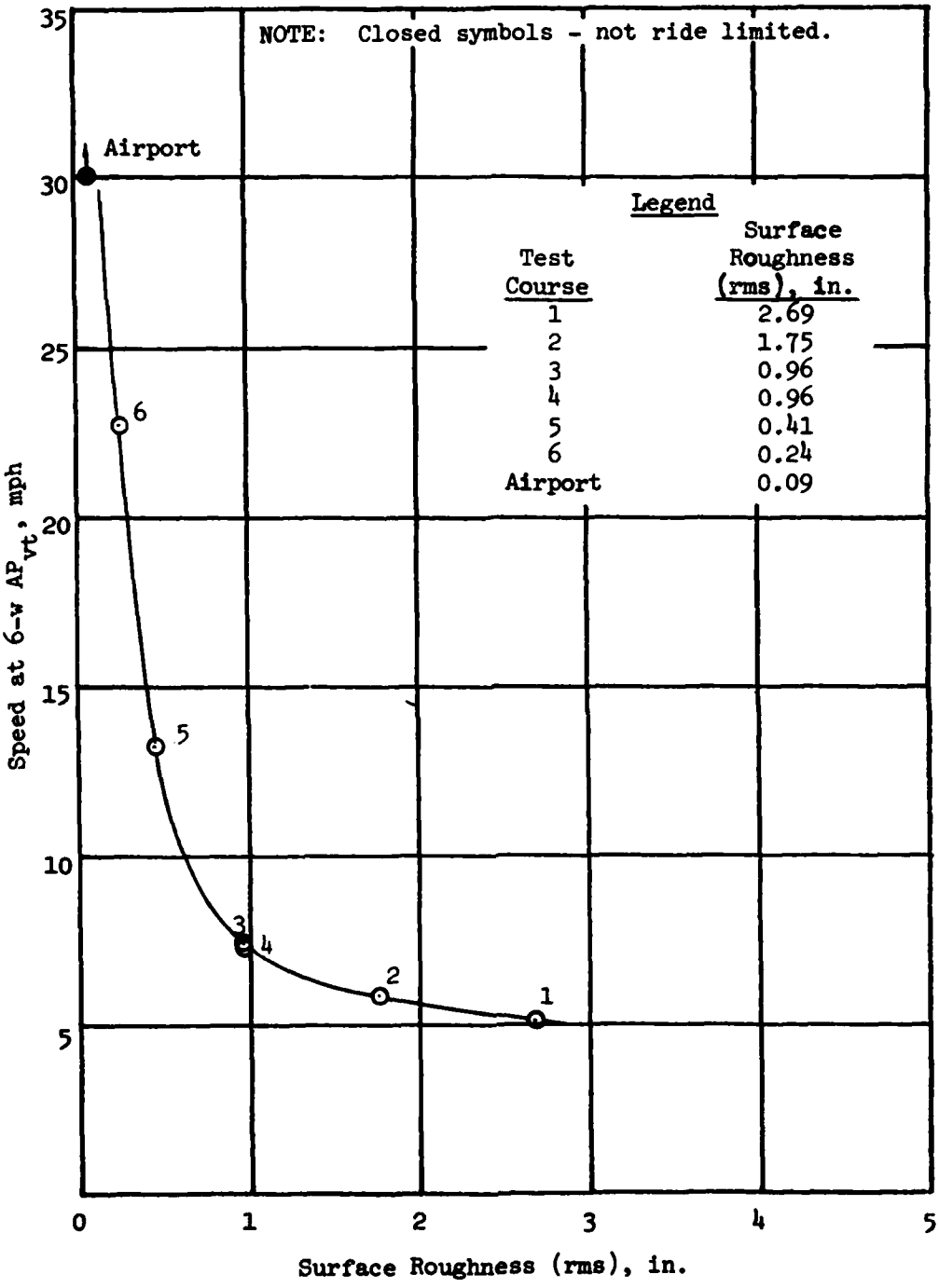
RIDE PERFORMANCE
JD544A FRONT-END LOADER
VERTICAL, DRIVER'S STATION
EMPTY, 50-PSI TIRE PRESSURE

PLATE 16



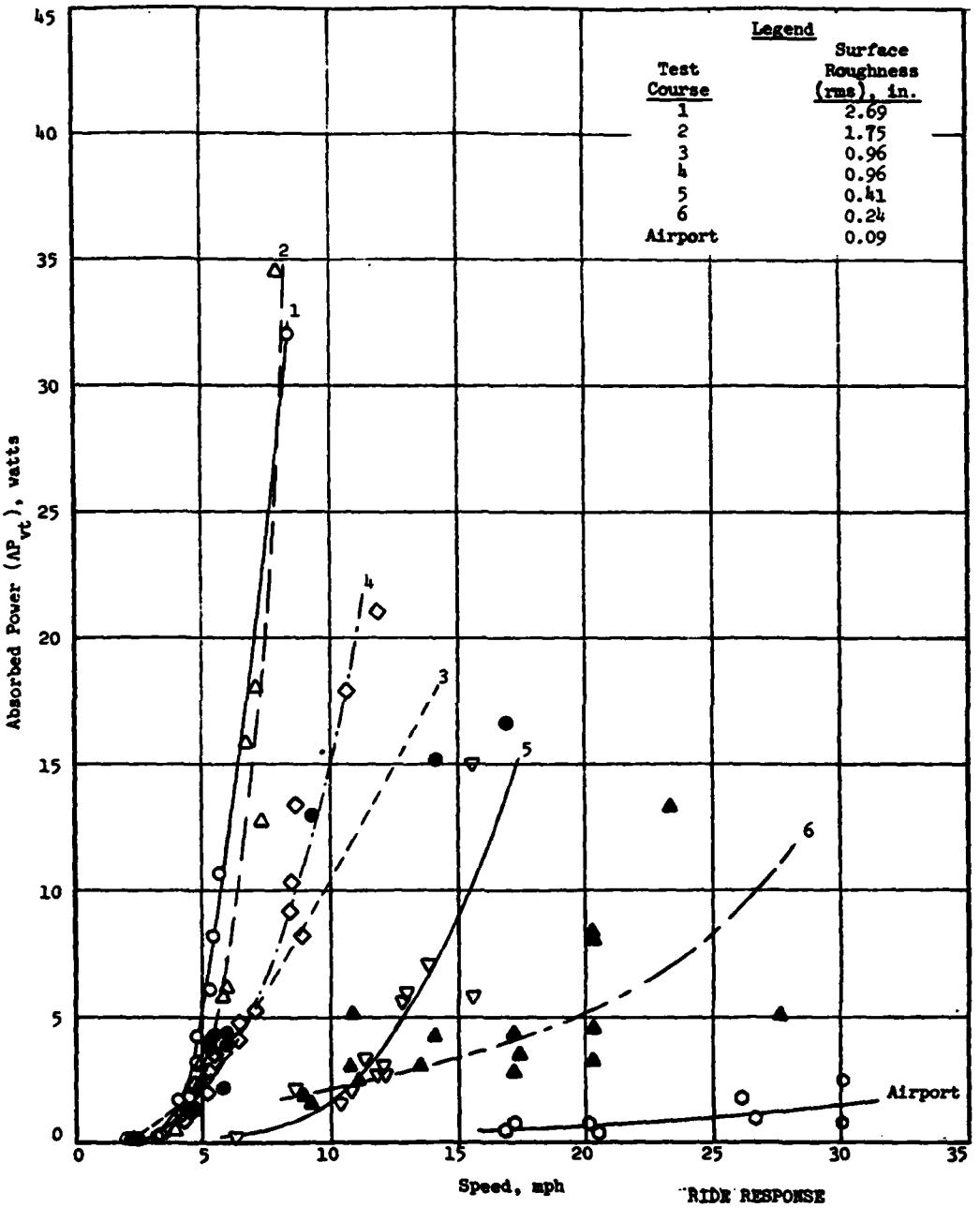
RIDE RESPONSE
JD544A FRONT-END LOADER
VERTICAL, DRIVER'S STATION
EMPTY, 50-PSI TIRE PRESSURE

PLATE 17



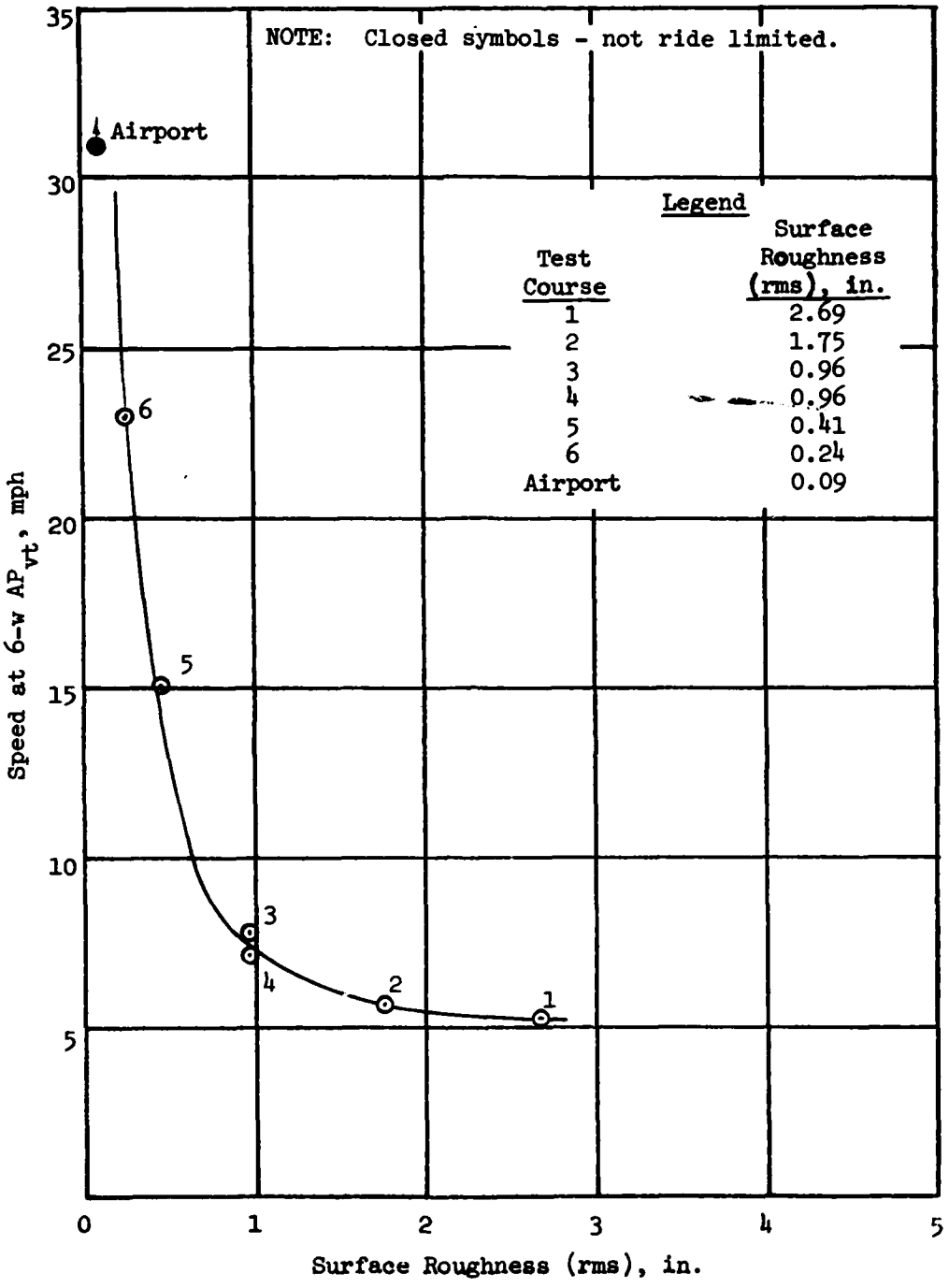
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, EMPTY
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 18



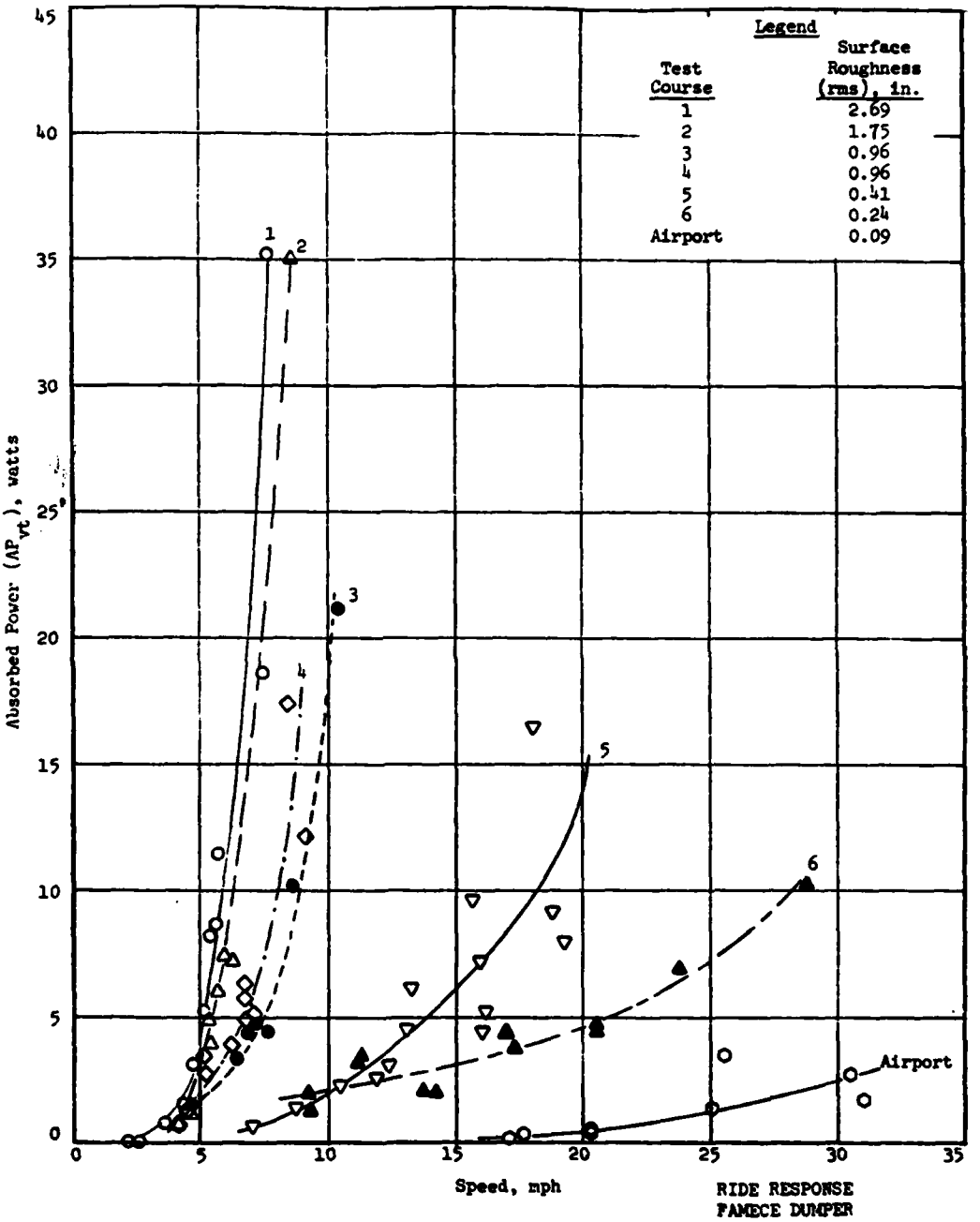
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, EMPTY
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 19



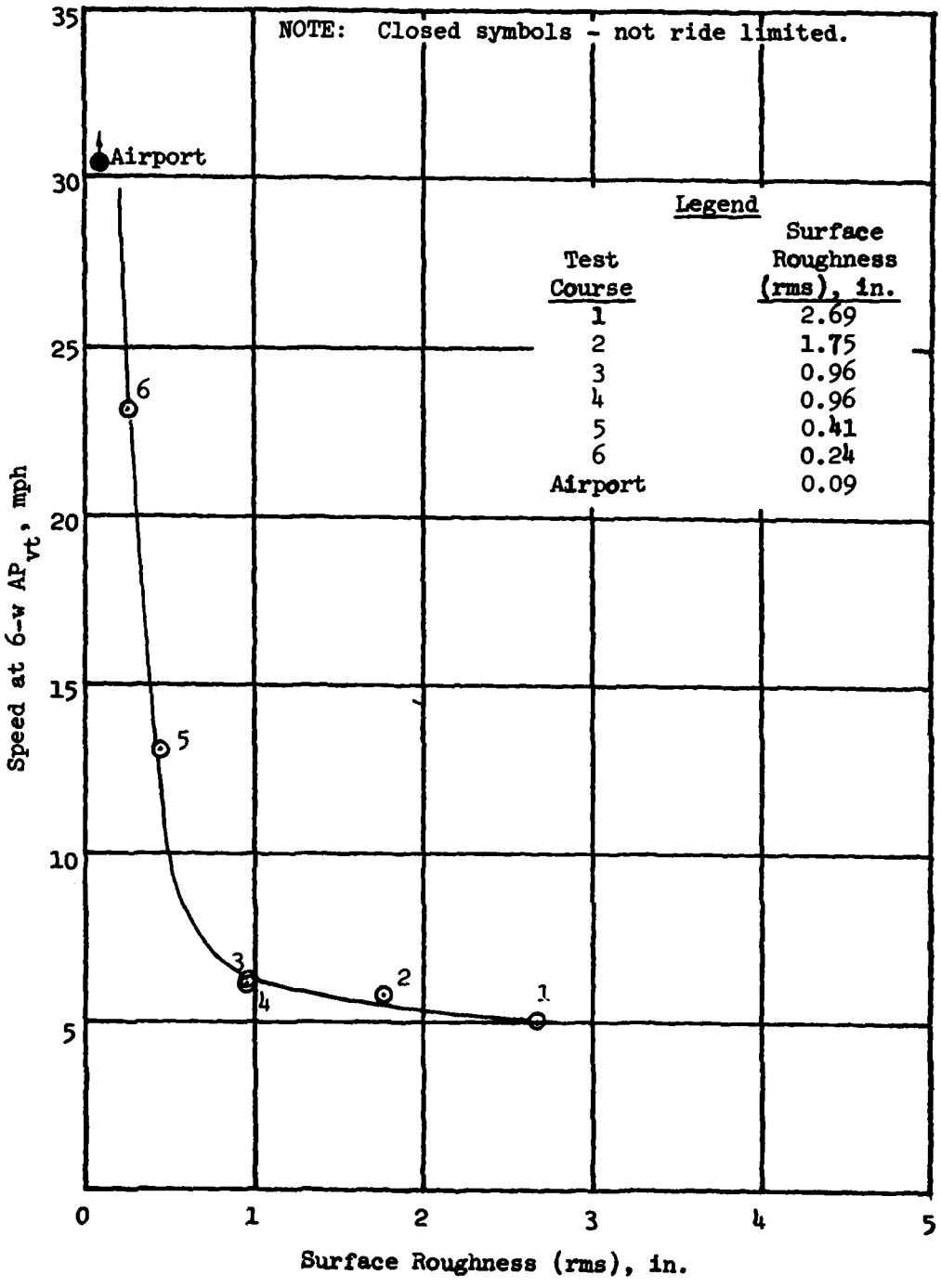
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, EMPTY
55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 20



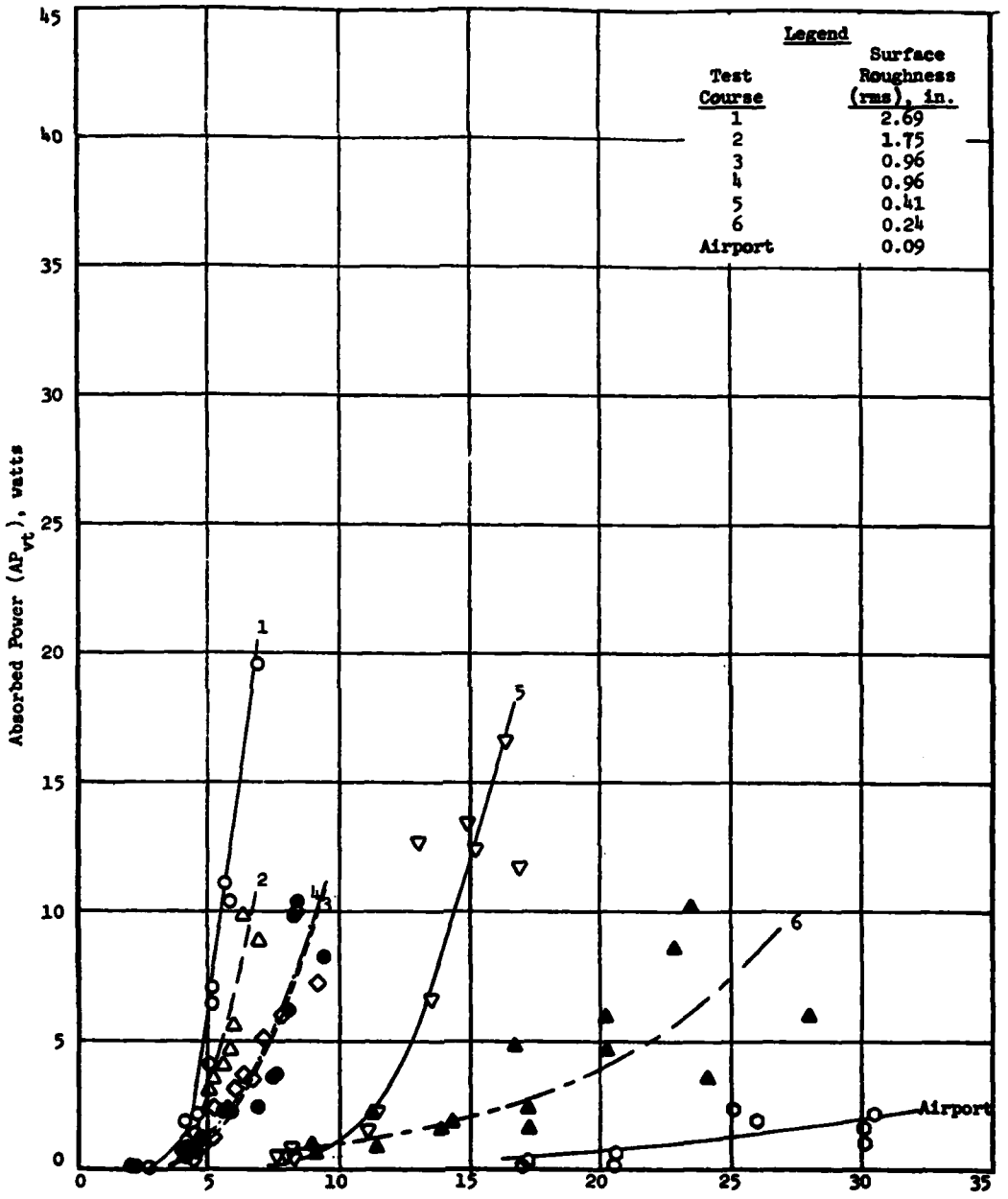
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, EMPTY
55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 21



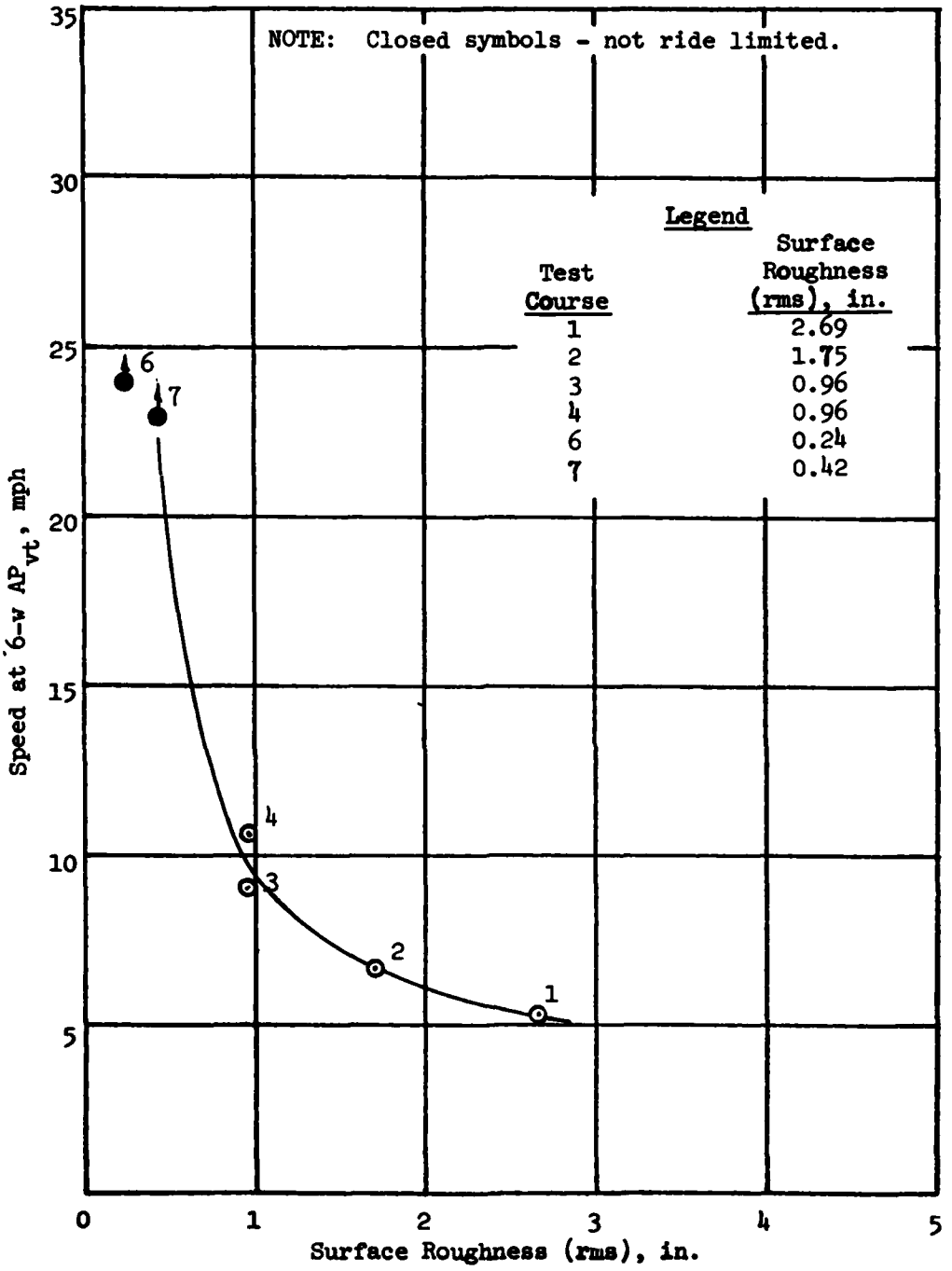
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, EMPTY
45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 22



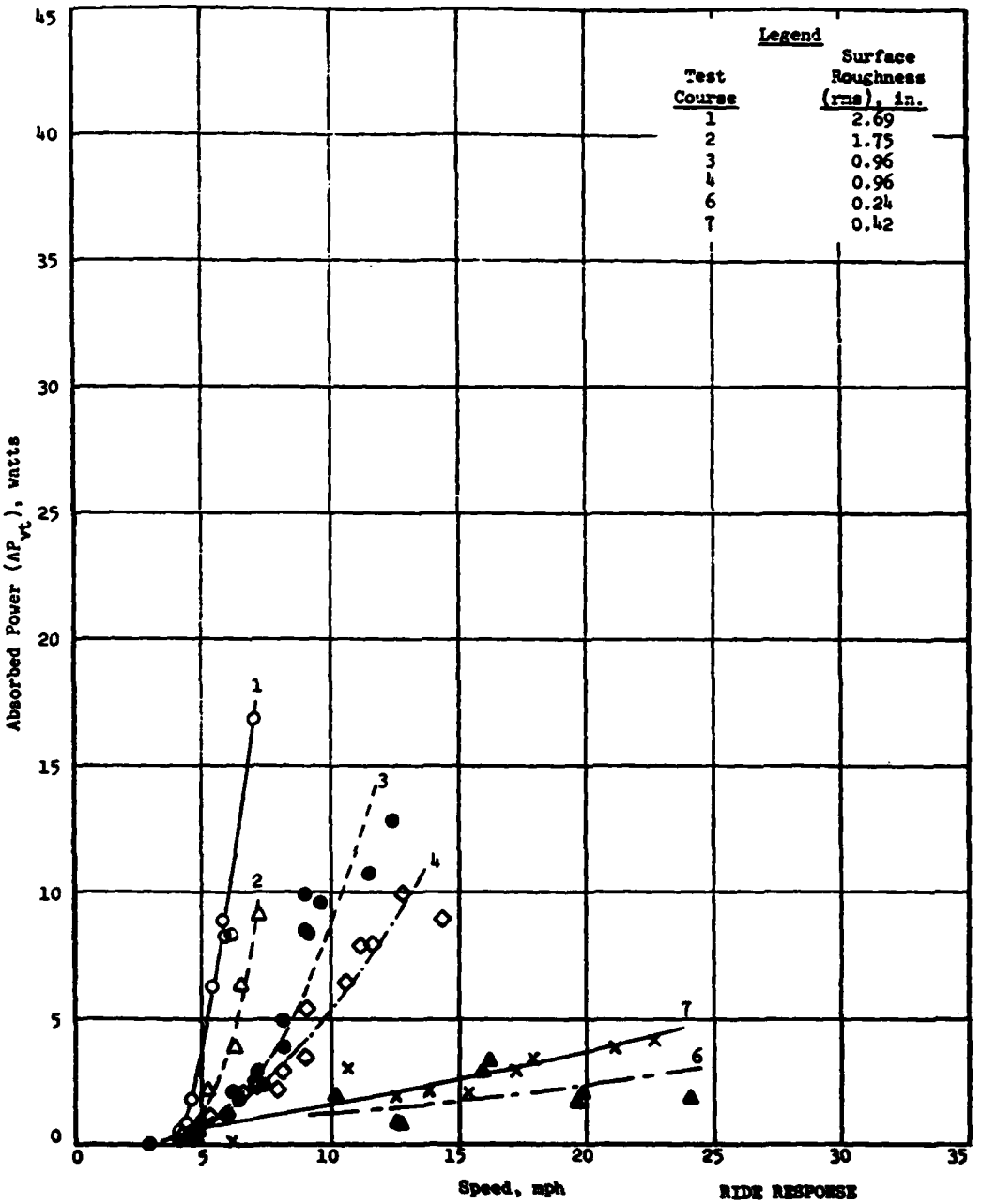
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, EMPTY
45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 23



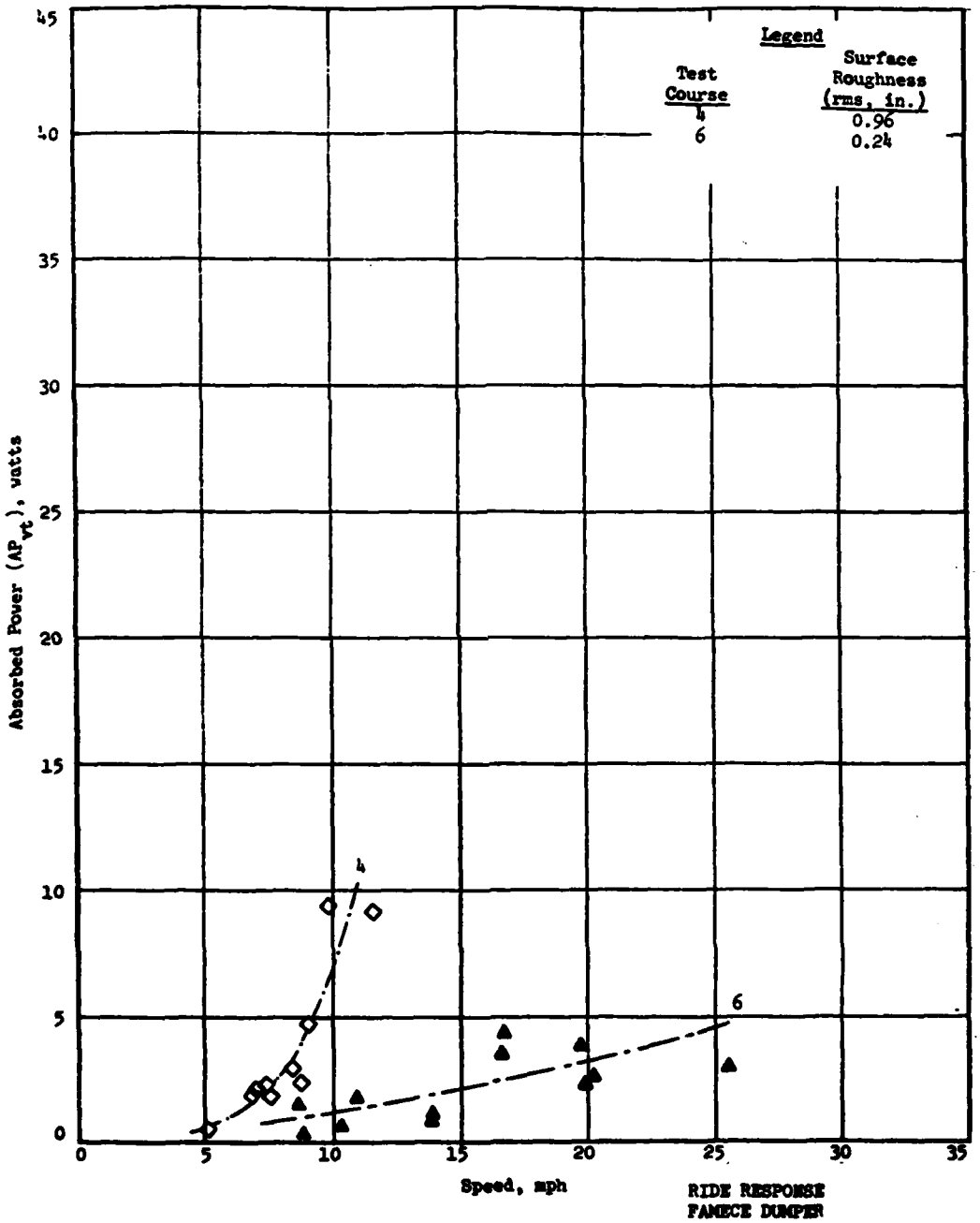
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, LOADED
55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 24



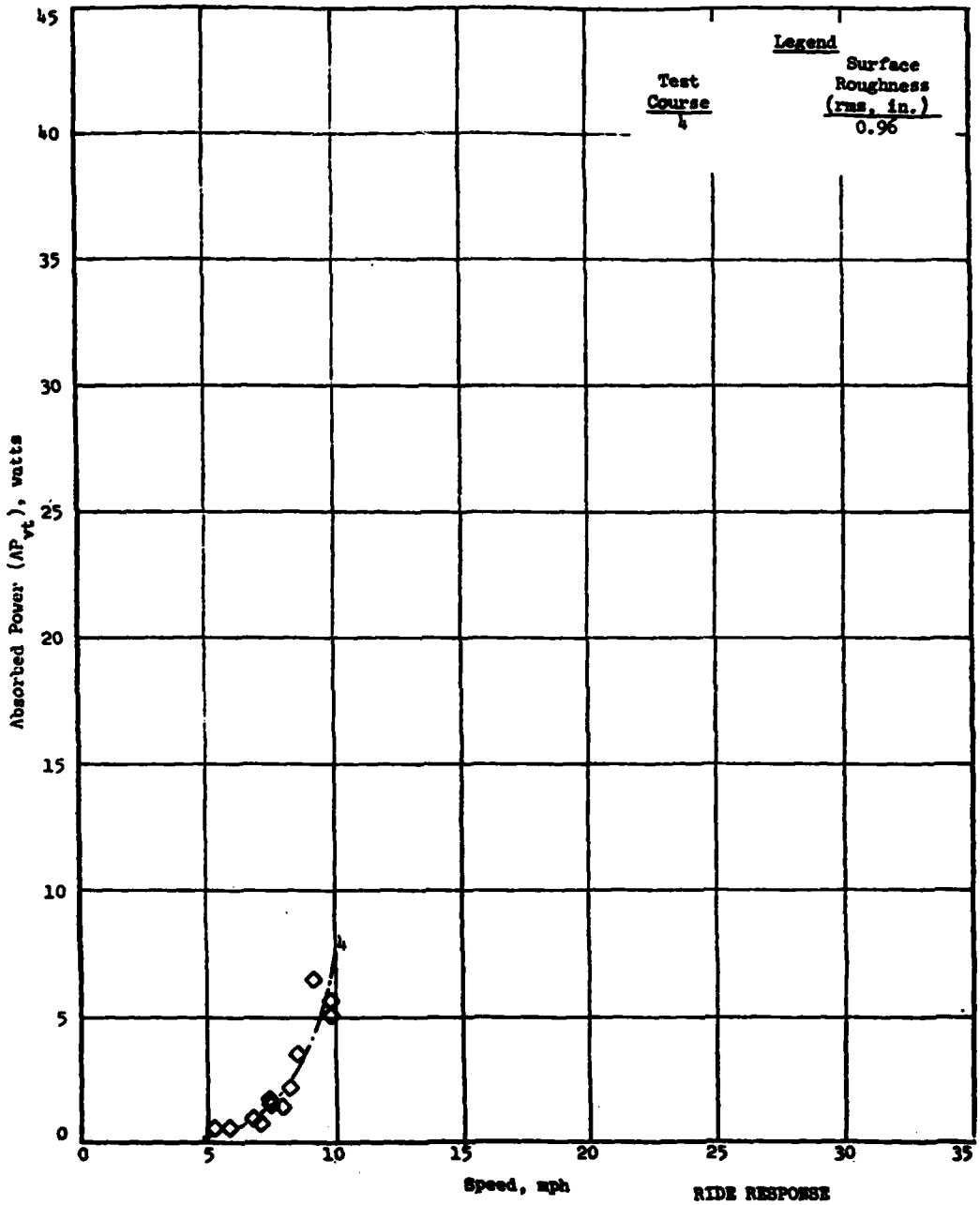
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, LOADED
55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 25



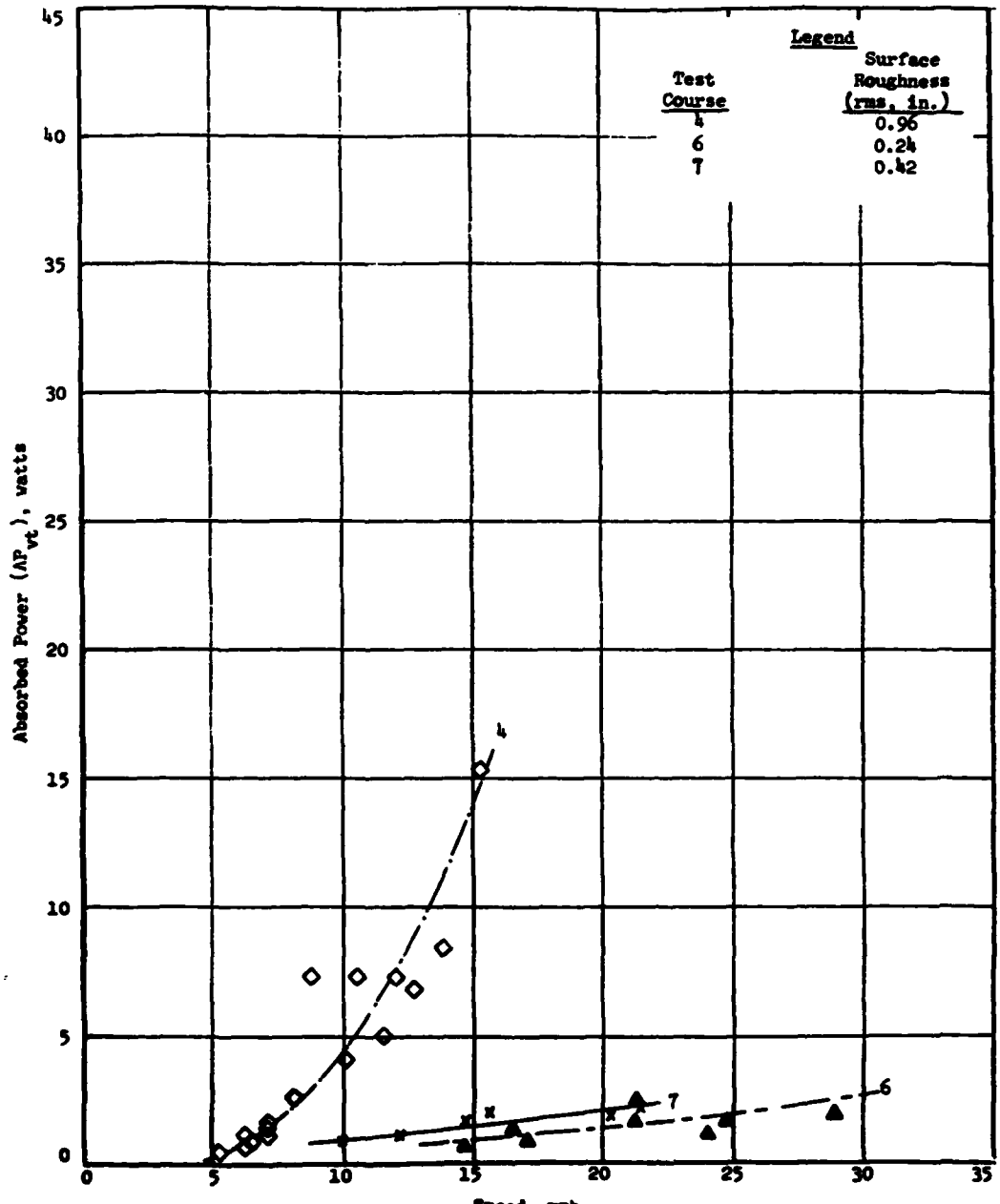
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, LOADED
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 26



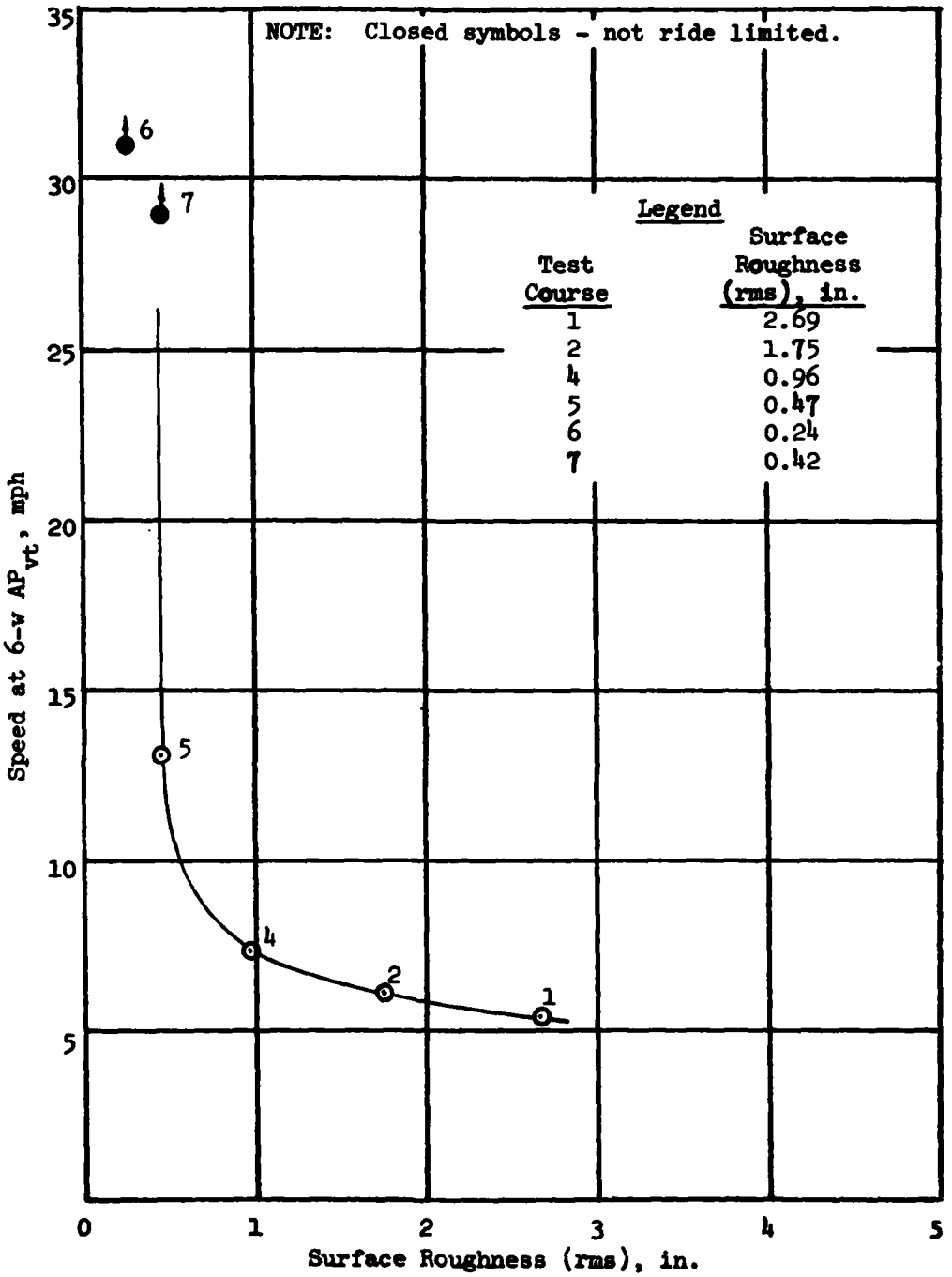
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, LOADED
45-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 27



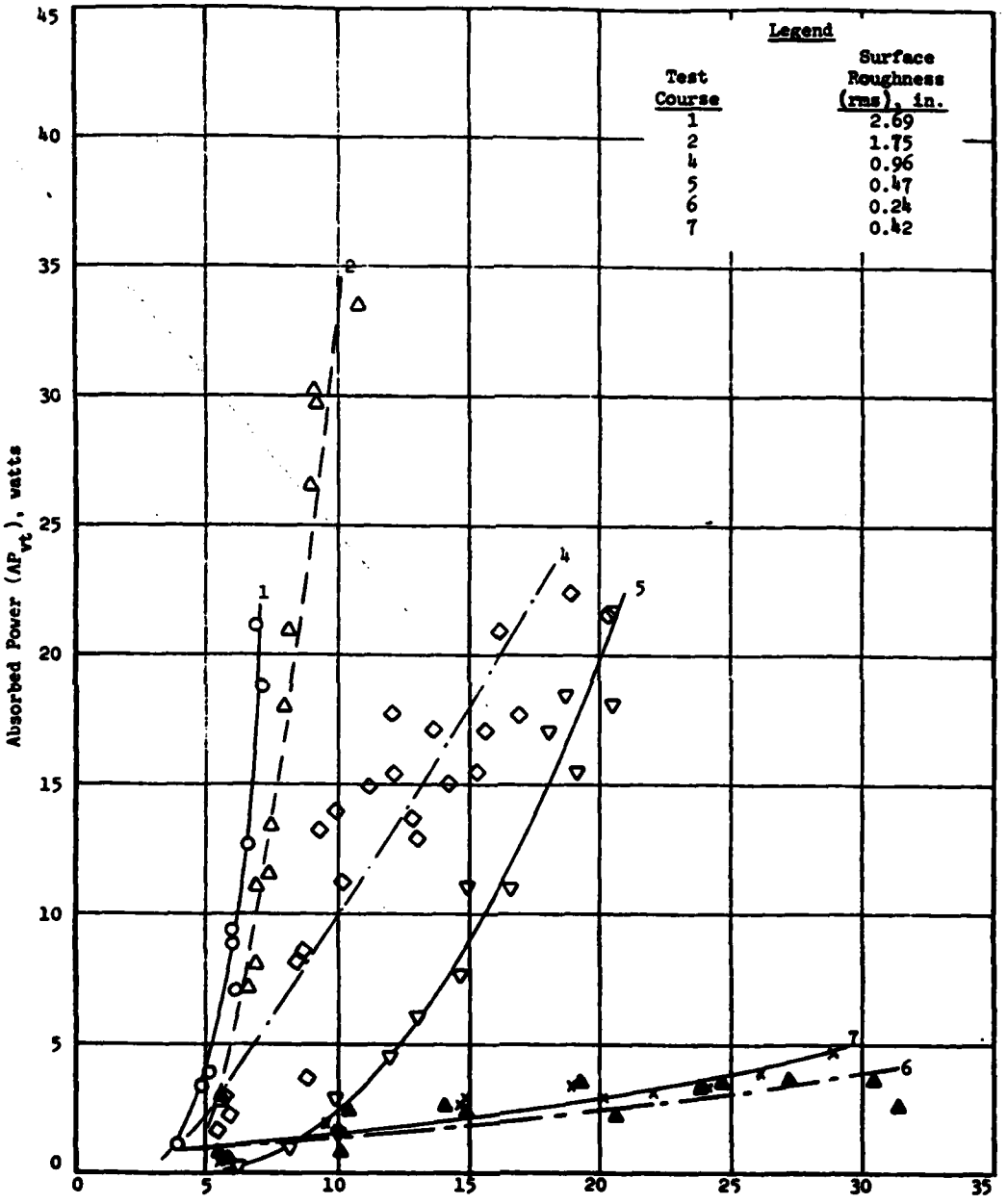
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, OBSERVER'S STATION, LOADED
45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 28



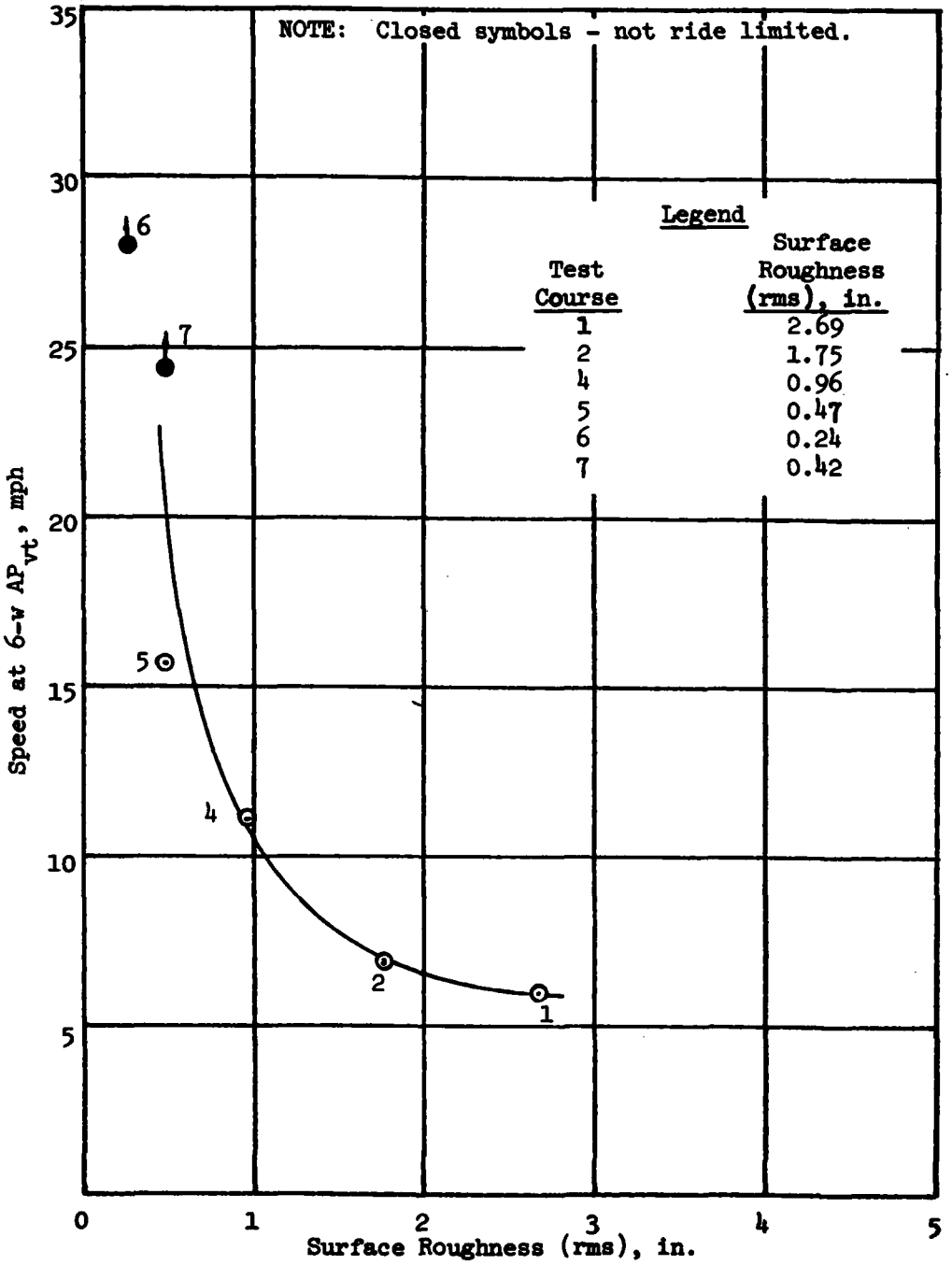
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, OBSERVER'S STATION
EMPTY, 35-PSI TIRE PRESSURE

PLATE 29



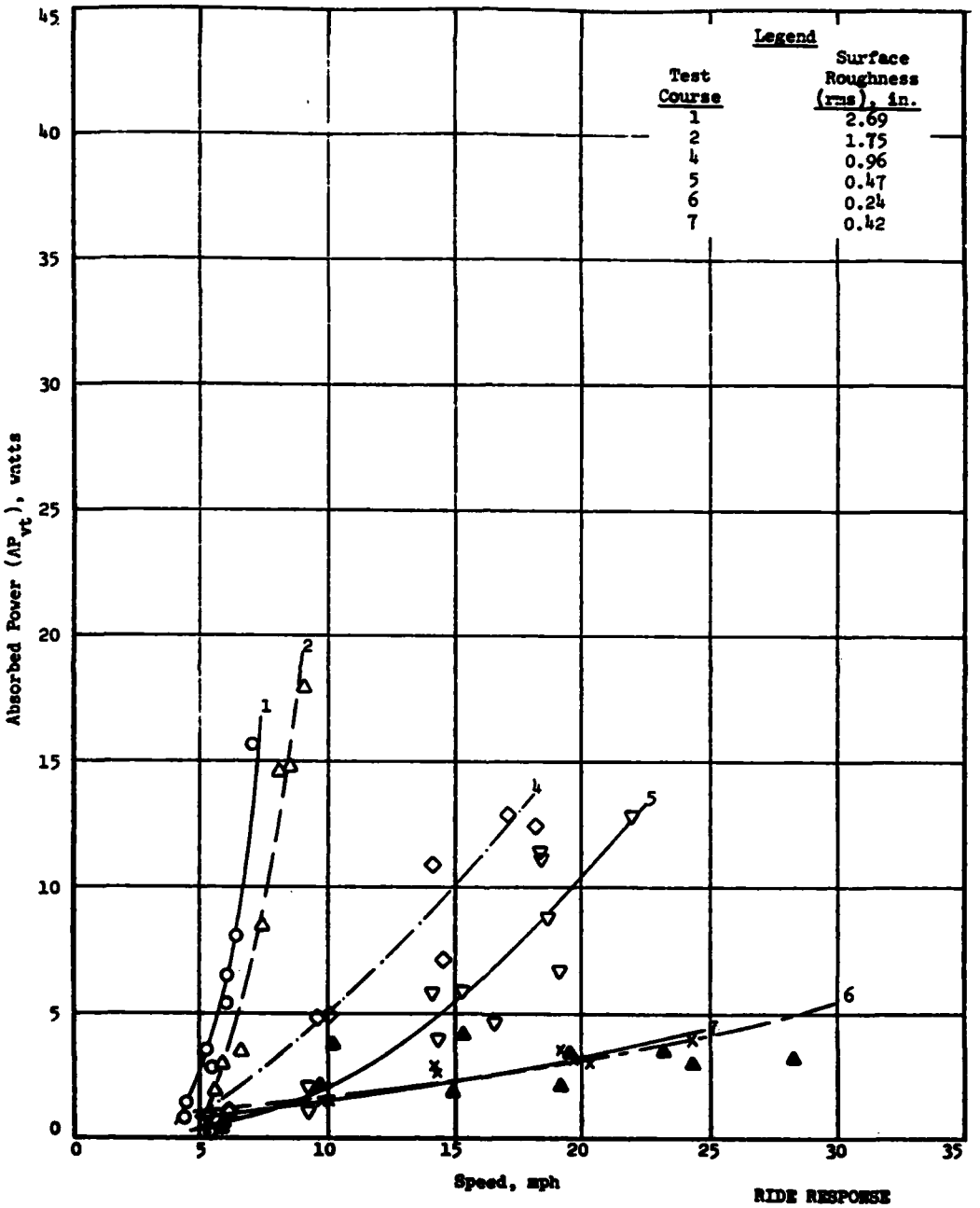
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, OBSERVER'S STATION
EMPTY, 35-PSI TIRE PRESSURE

PLATE 30



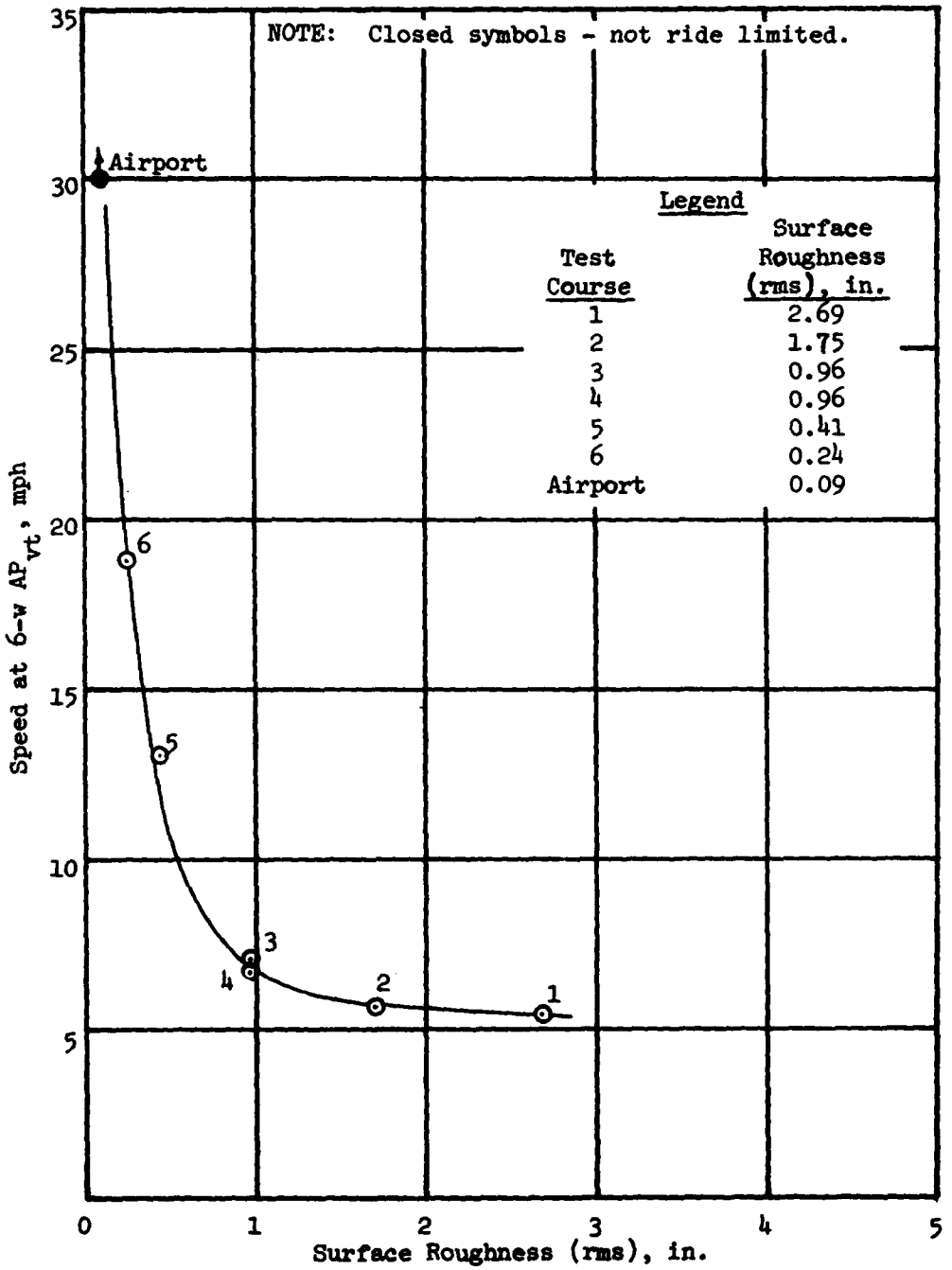
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, OBSERVER'S STATION
LOADED, 35-PSI TIRE PRESSURE

PLATE 31



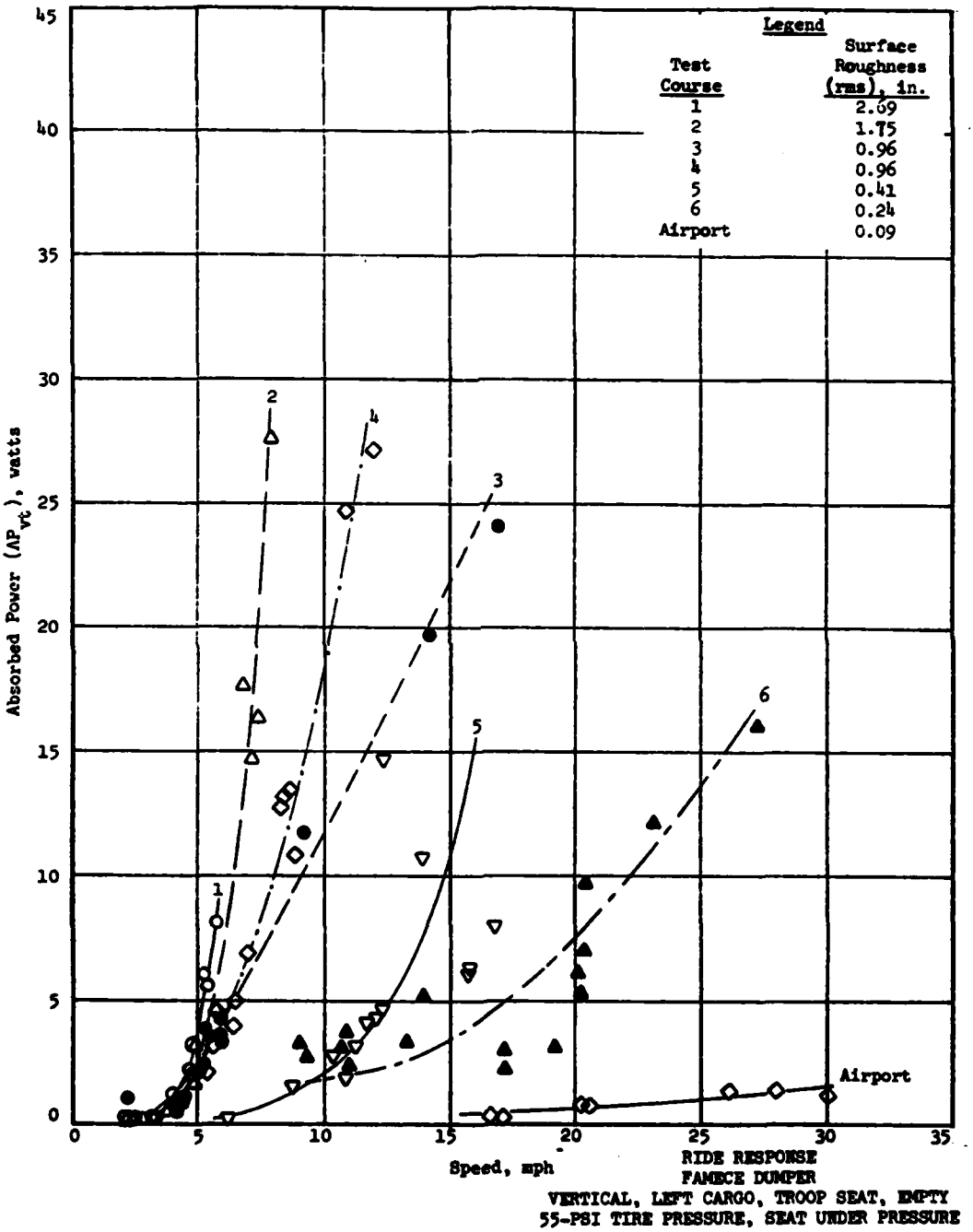
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, OBSERVER'S STATION
LOADED, 35-PSI TIRE PRESSURE

PLATE 32



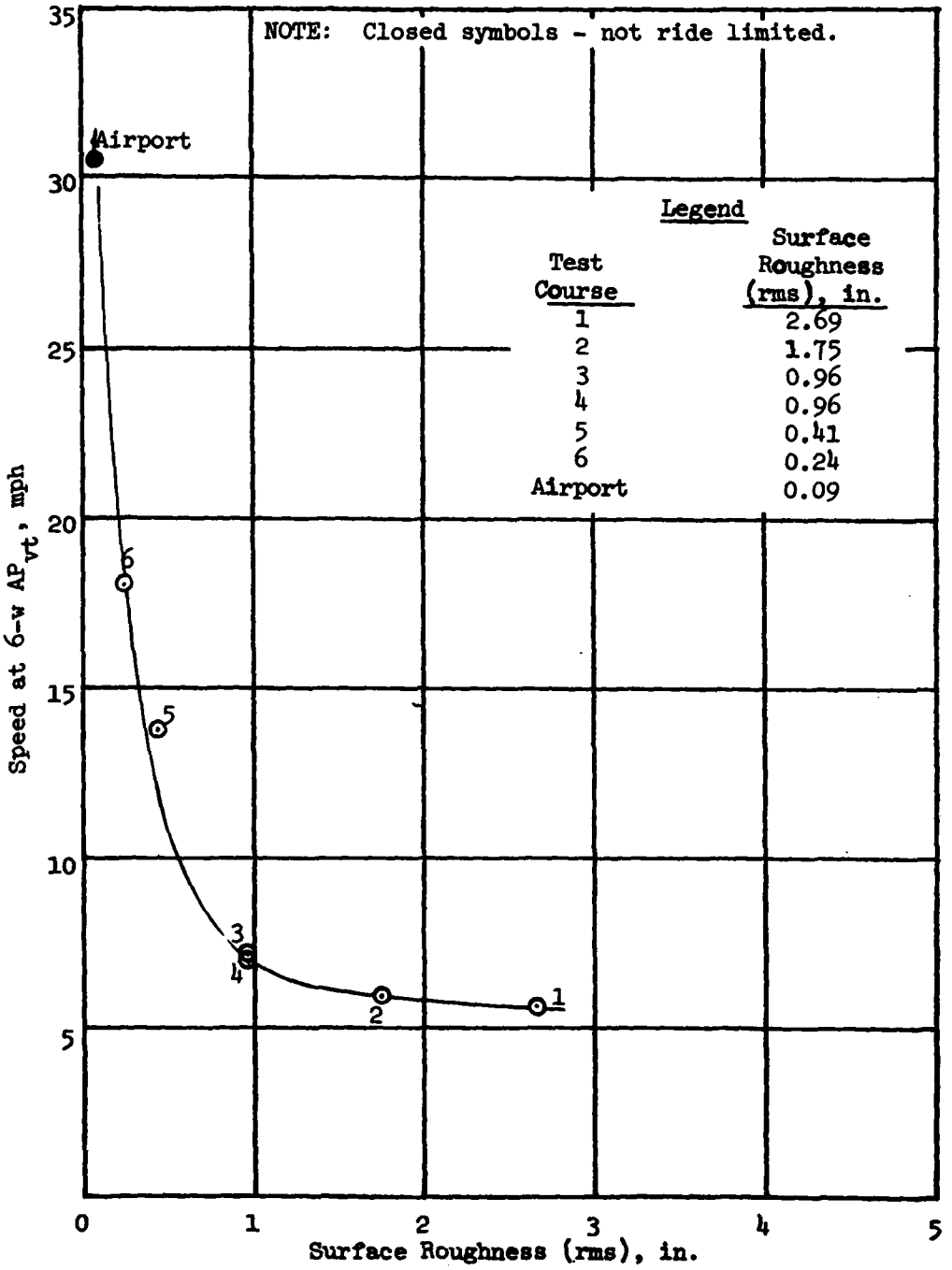
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT, EMPTY
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 33



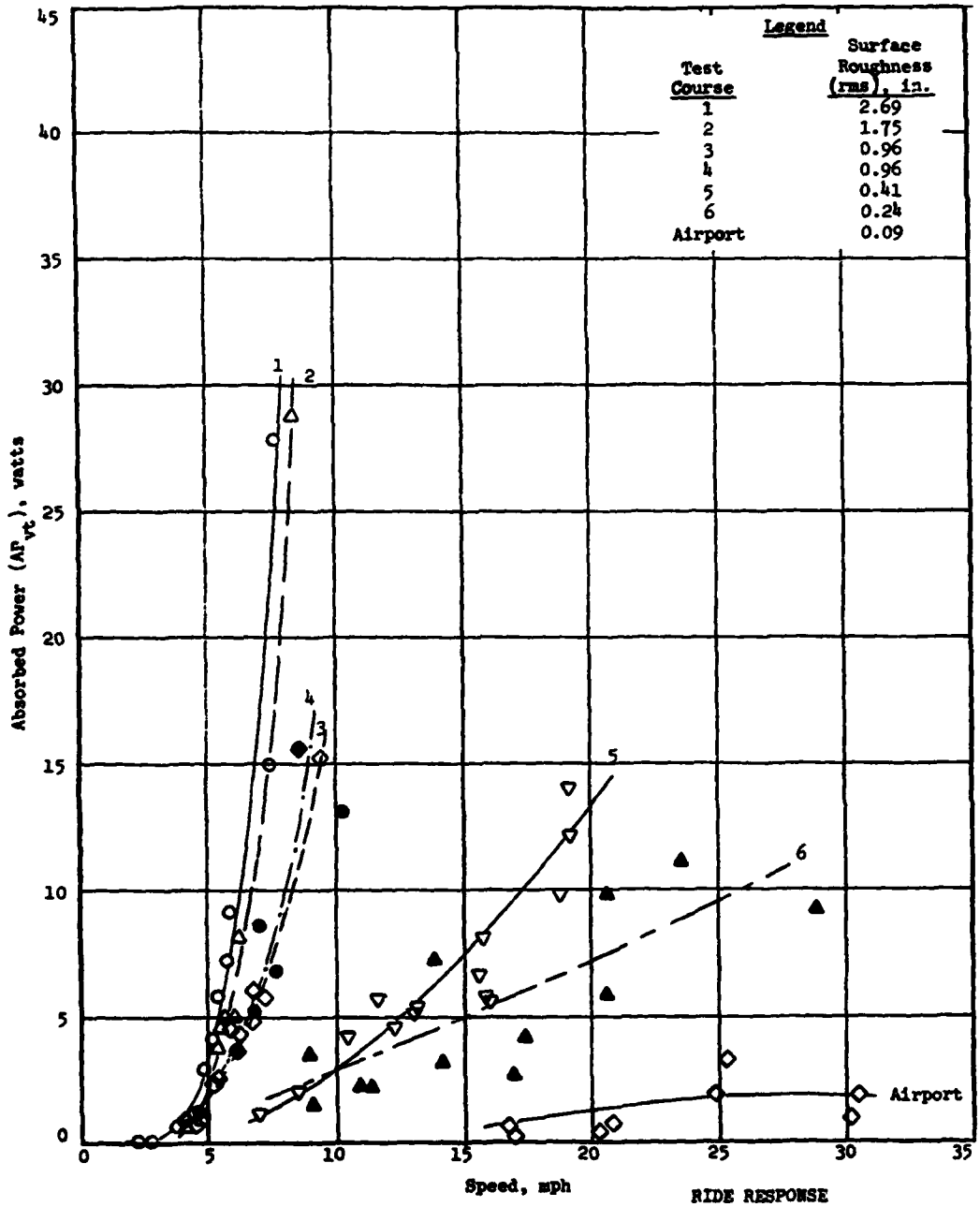
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT, EMPTY
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 34



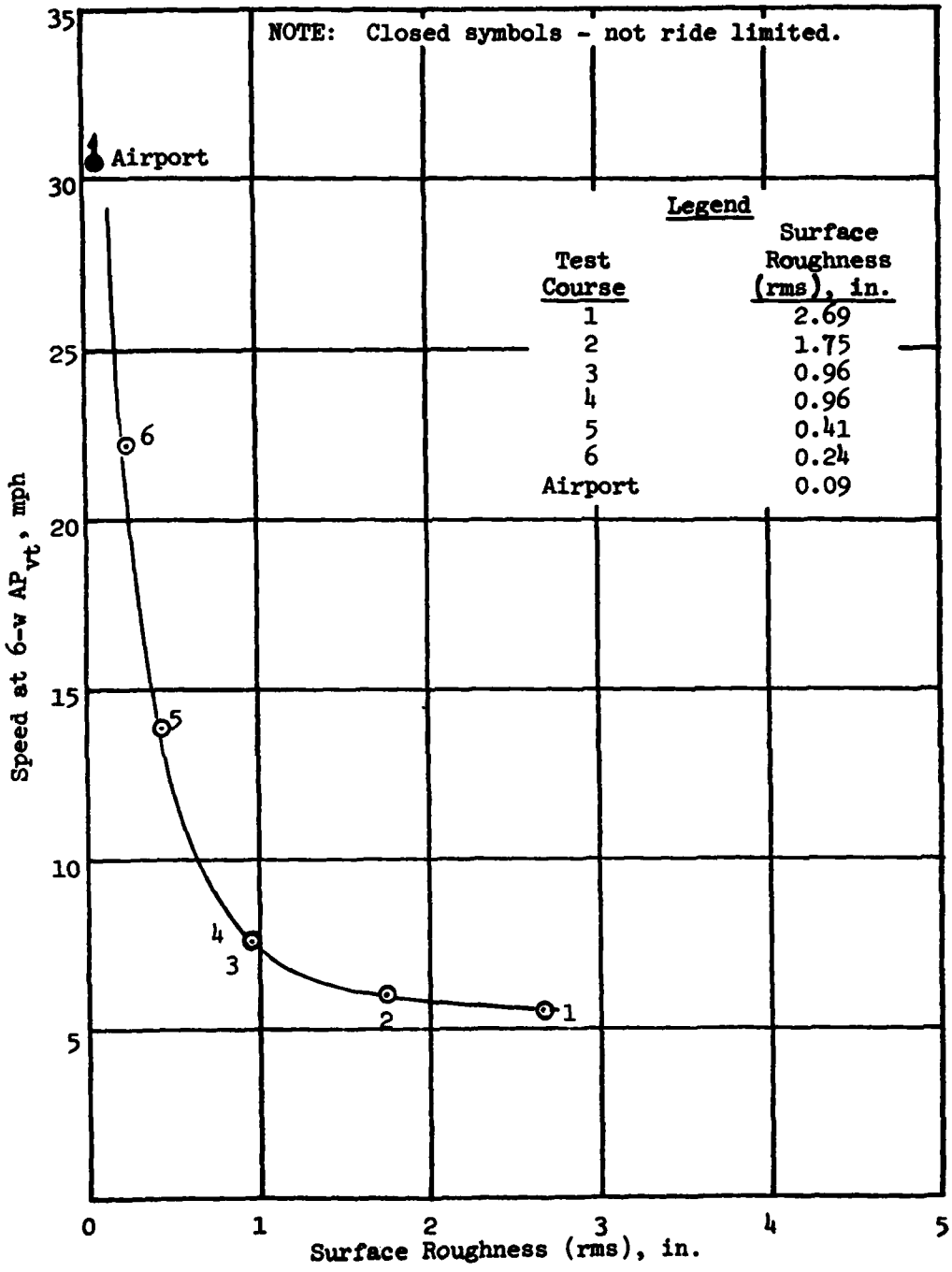
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT
EMPTY, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 35



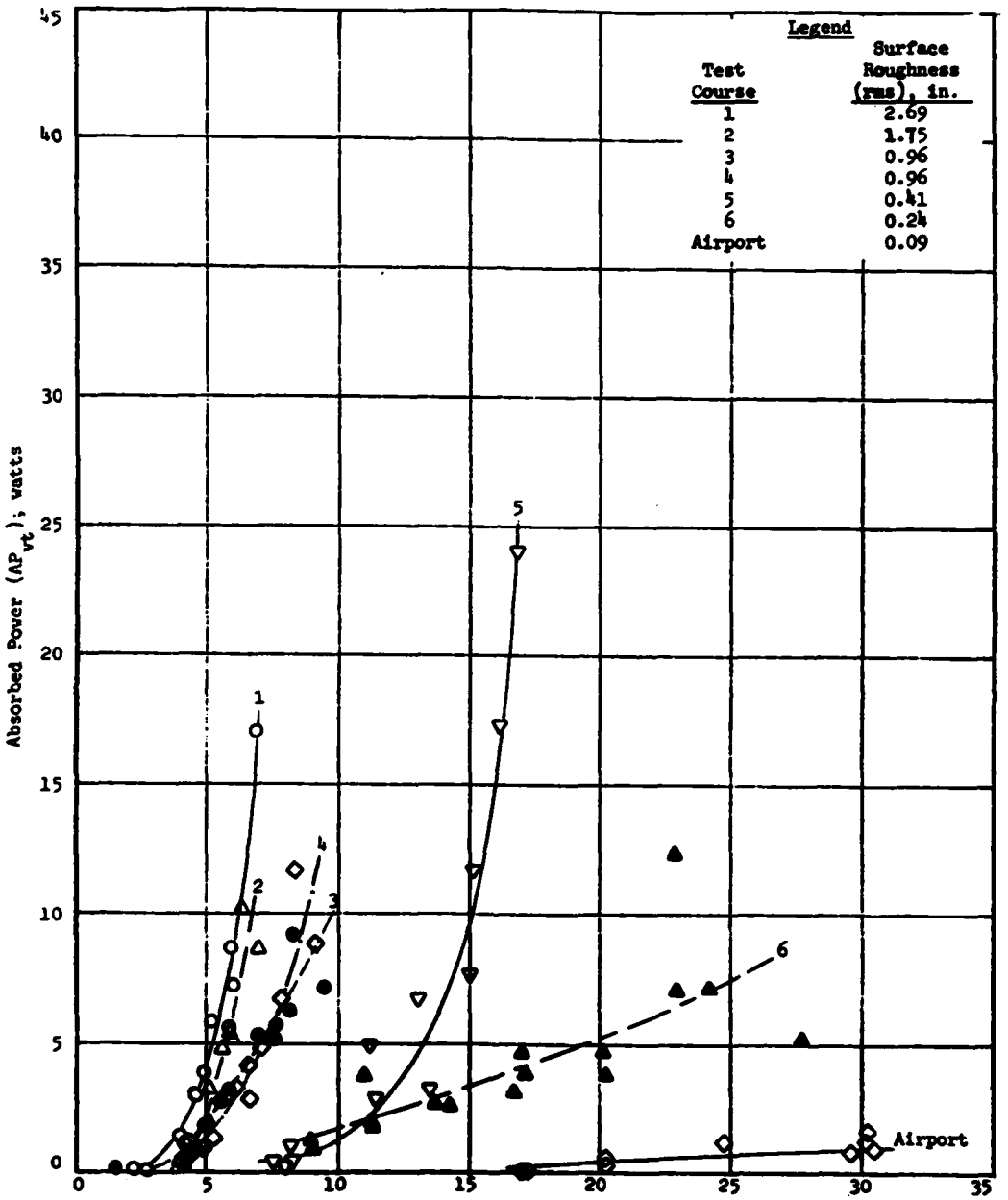
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT
EMPTY, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 36



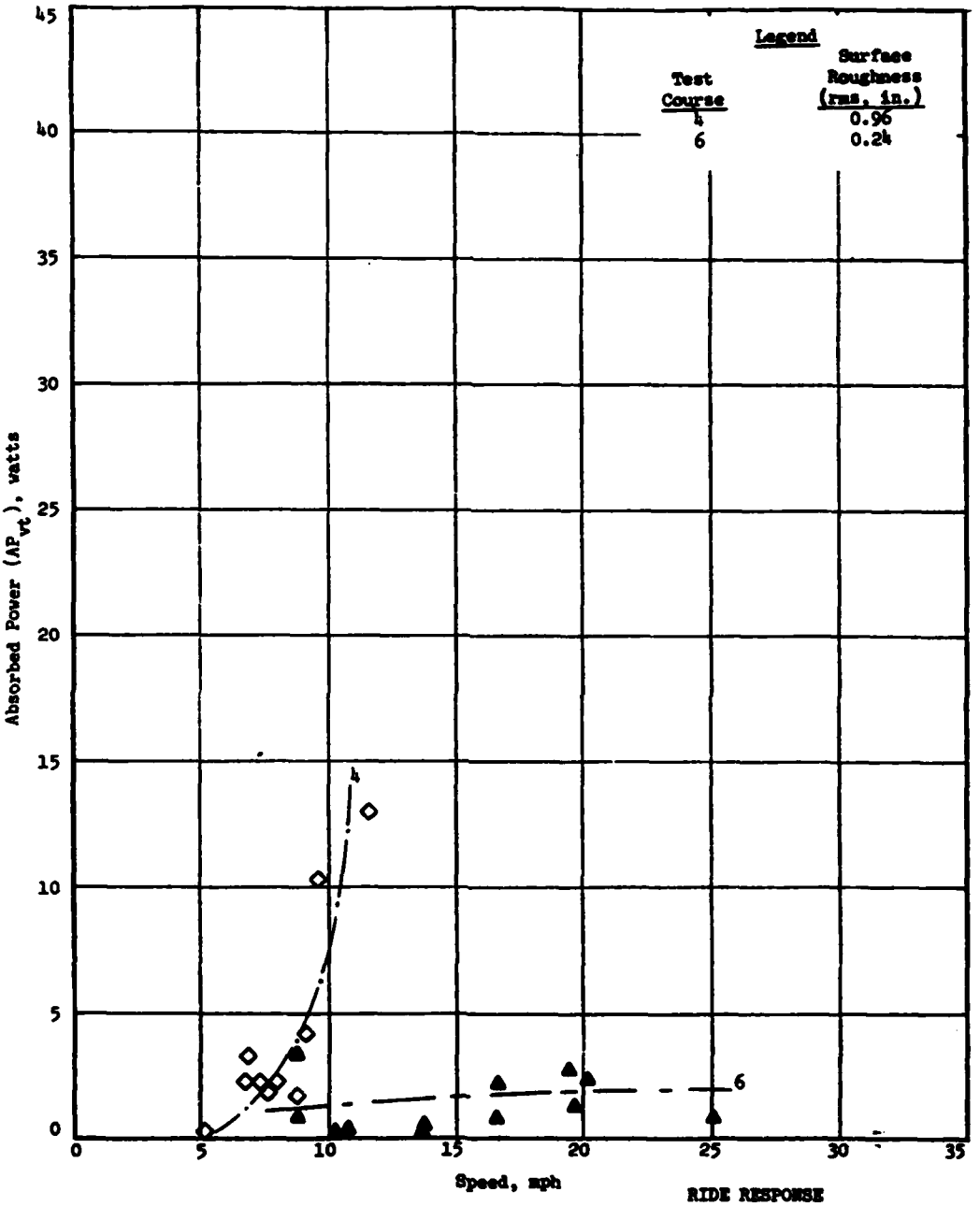
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT
EMPTY, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 37



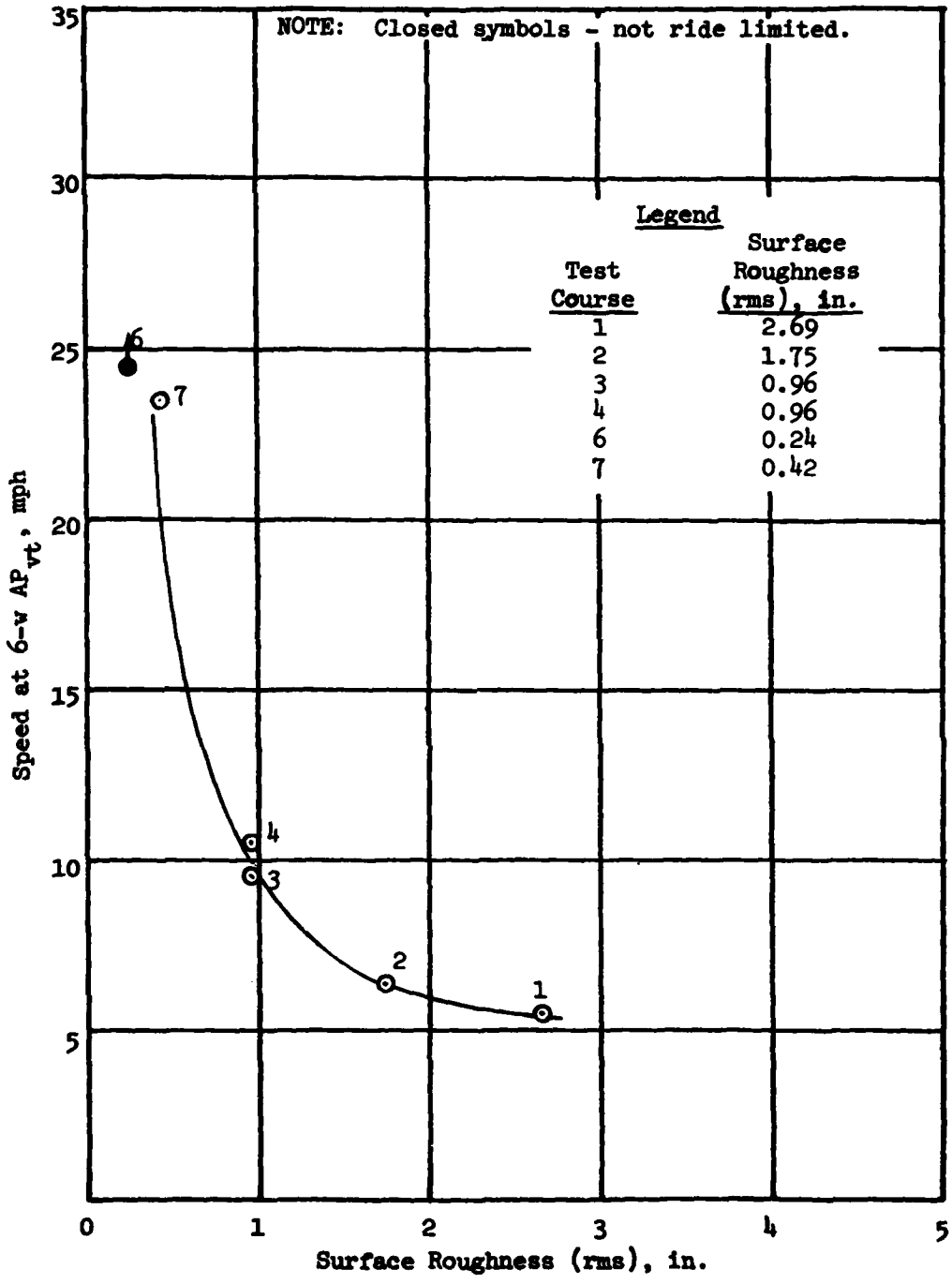
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, LEFT CARCO, TROOP SEAT
EMPTY, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 38



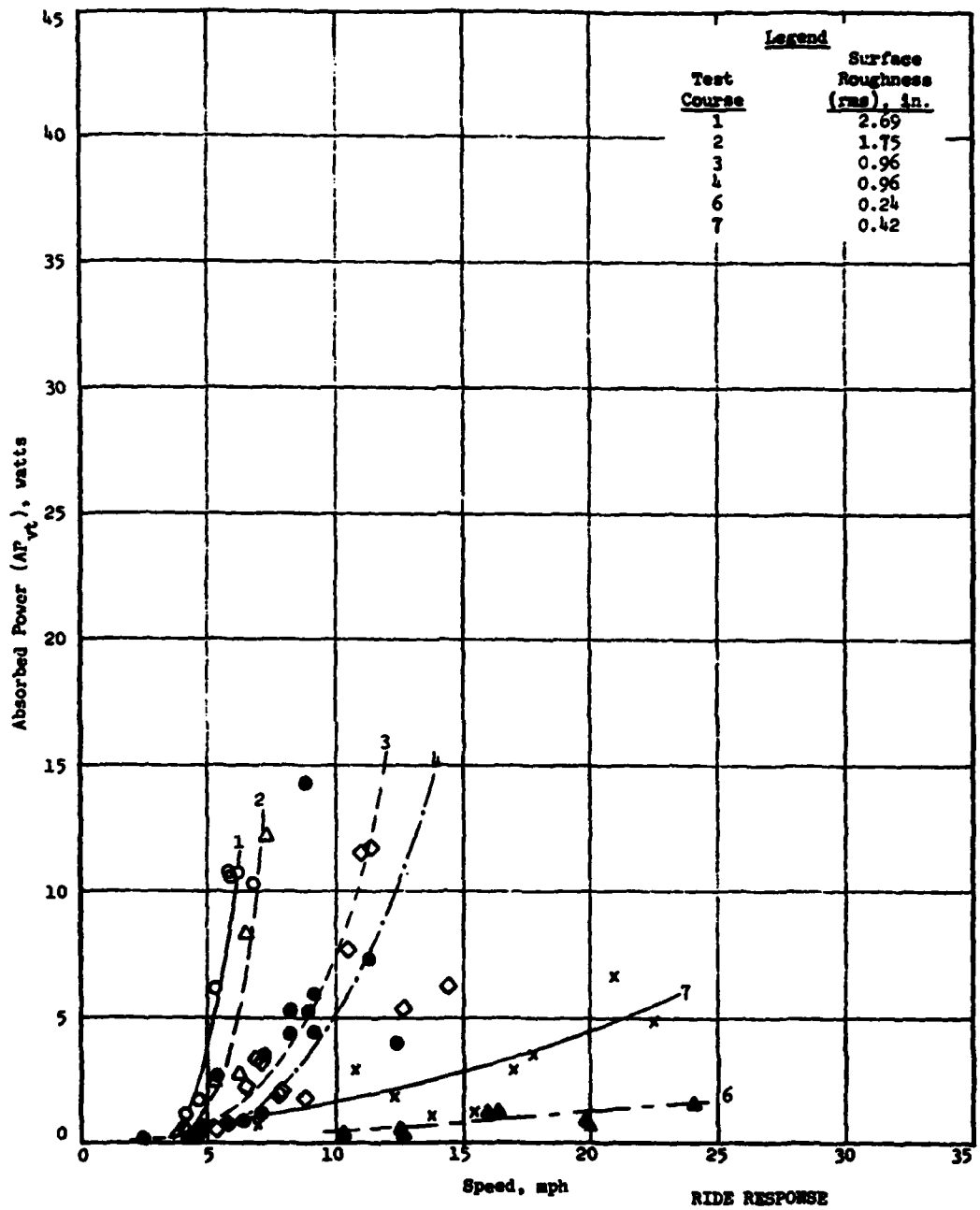
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT, LOADED
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 39



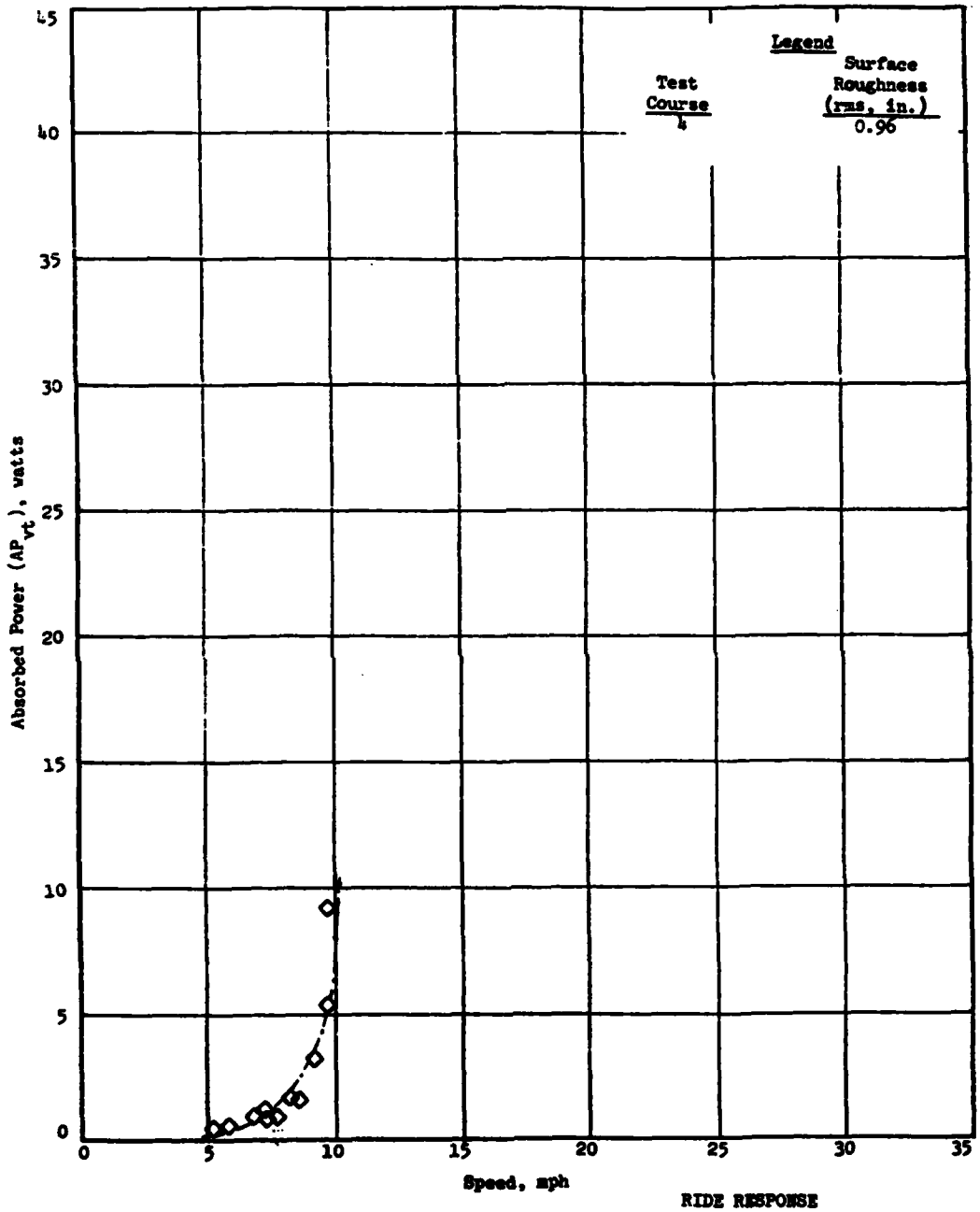
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT
LOADED, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 40



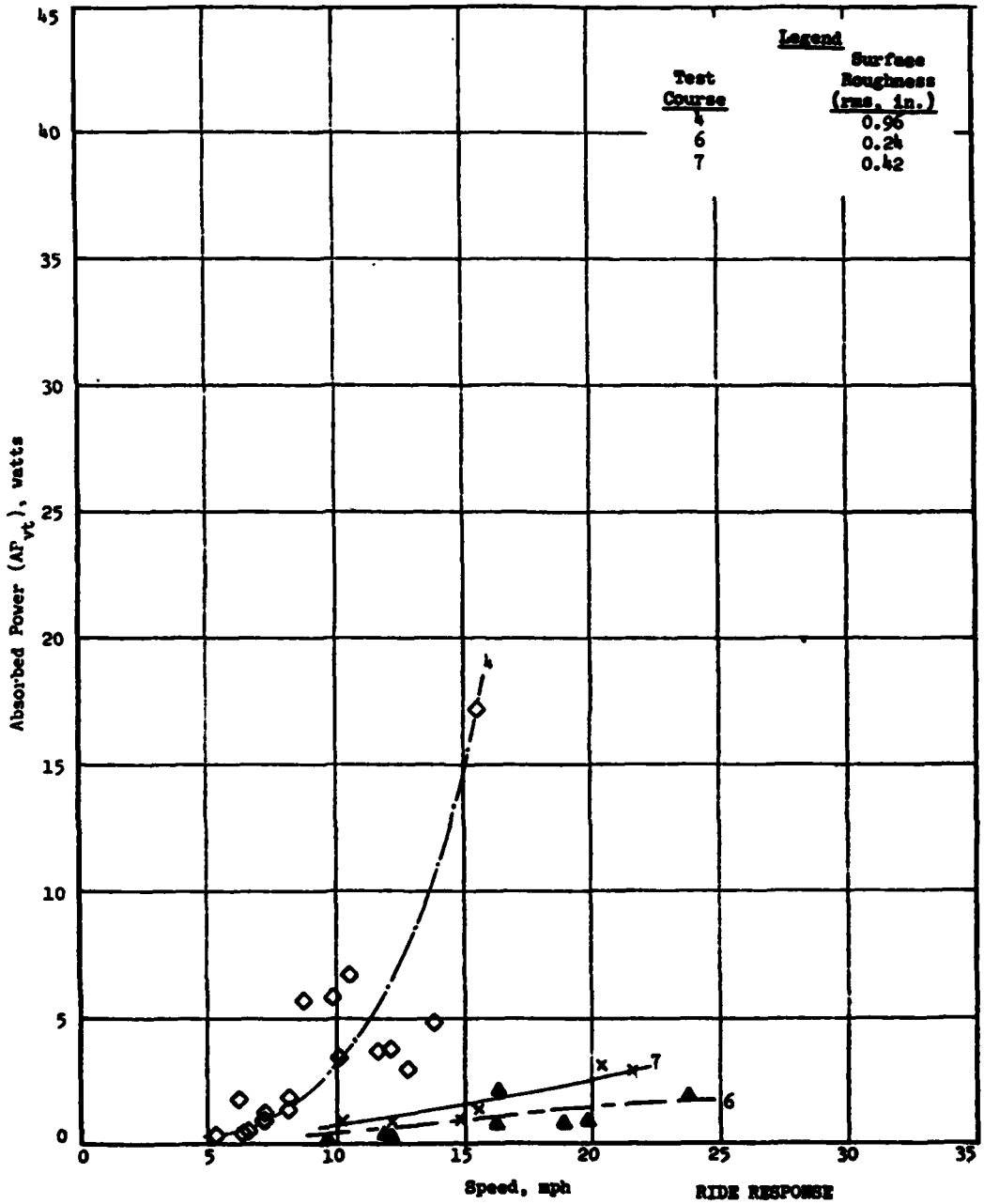
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT
LOADED, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 41



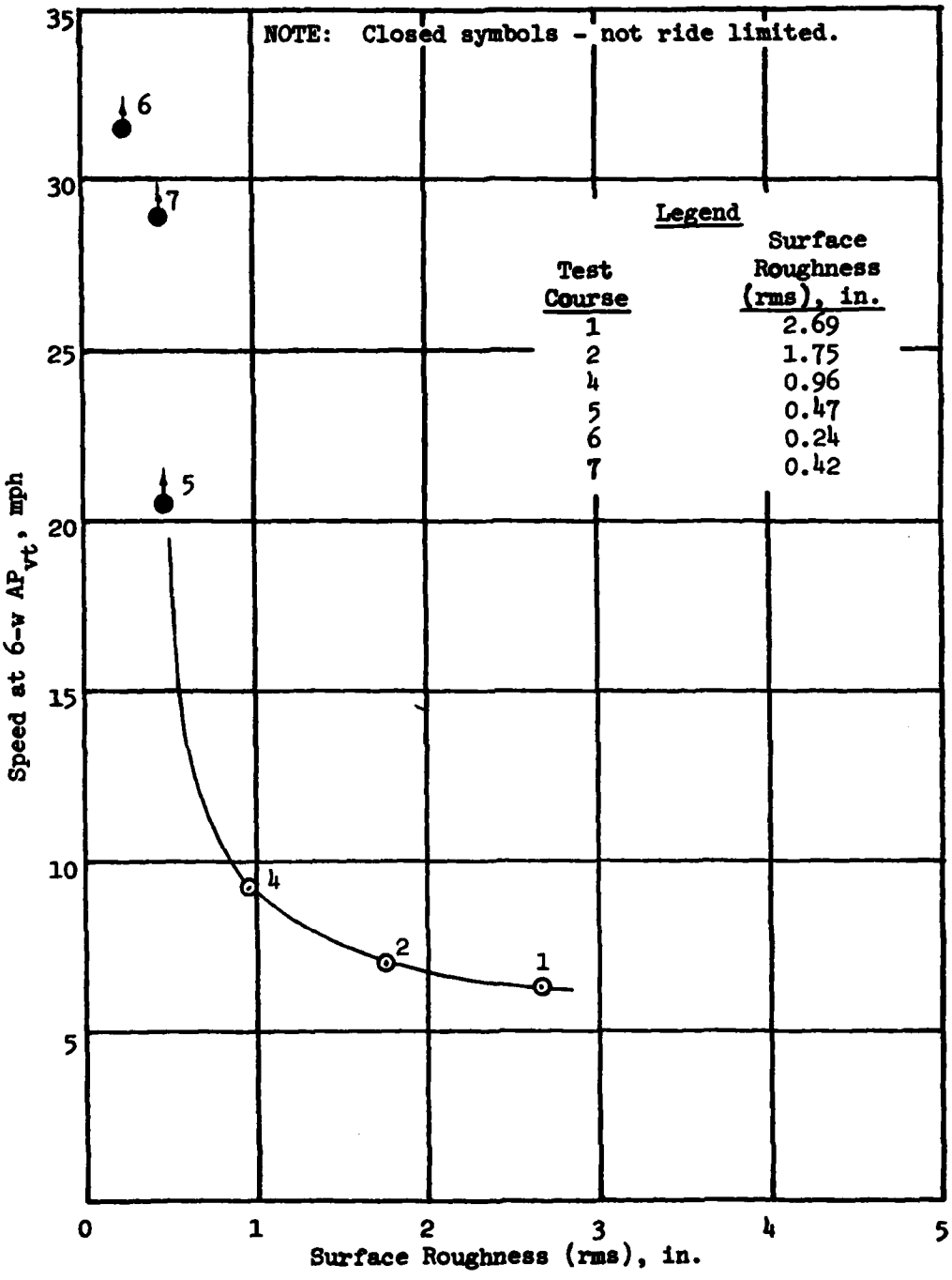
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT, LOADED
45-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 42



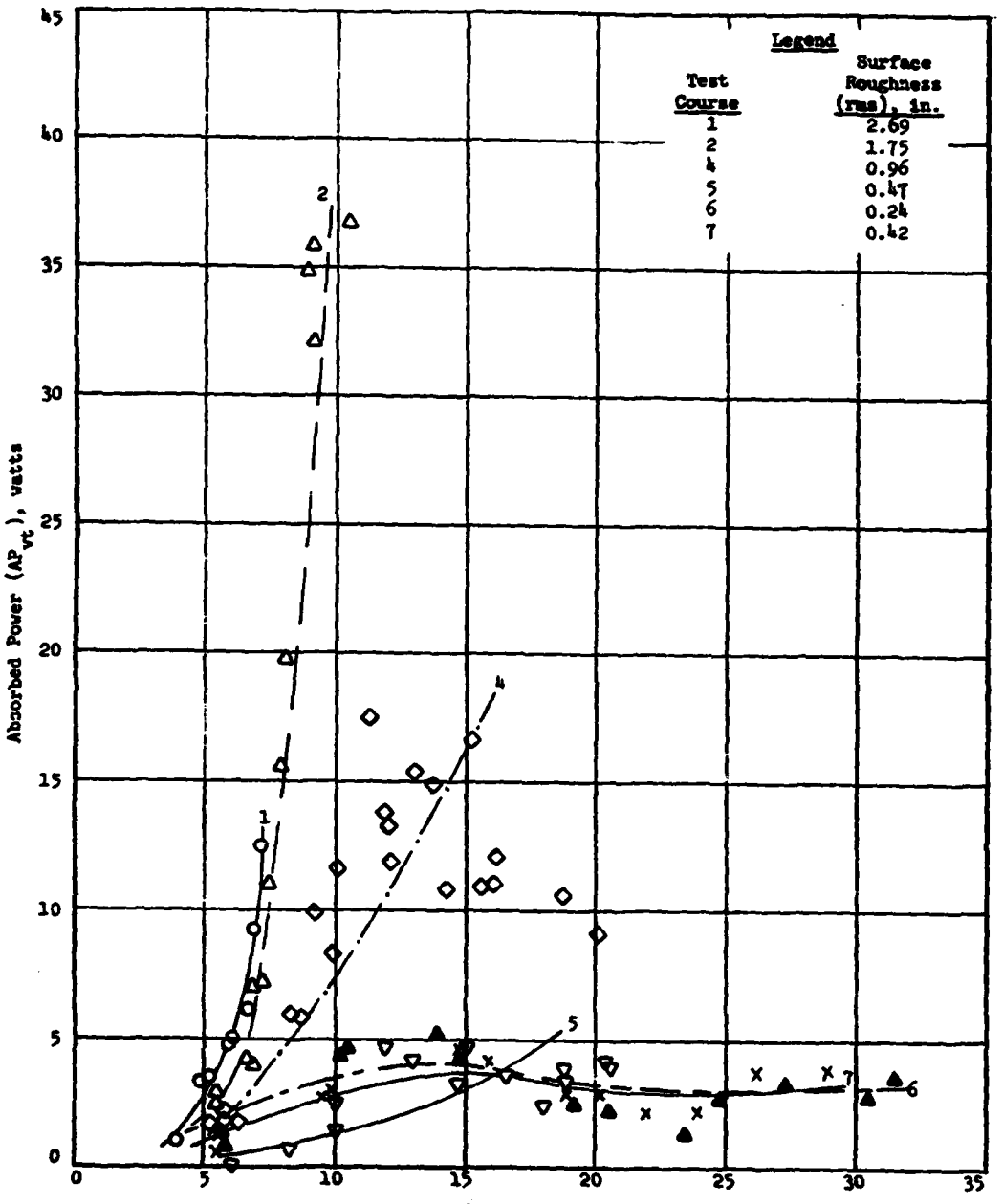
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, LEFT CARGO, TROOP SEAT
LOADED, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 43



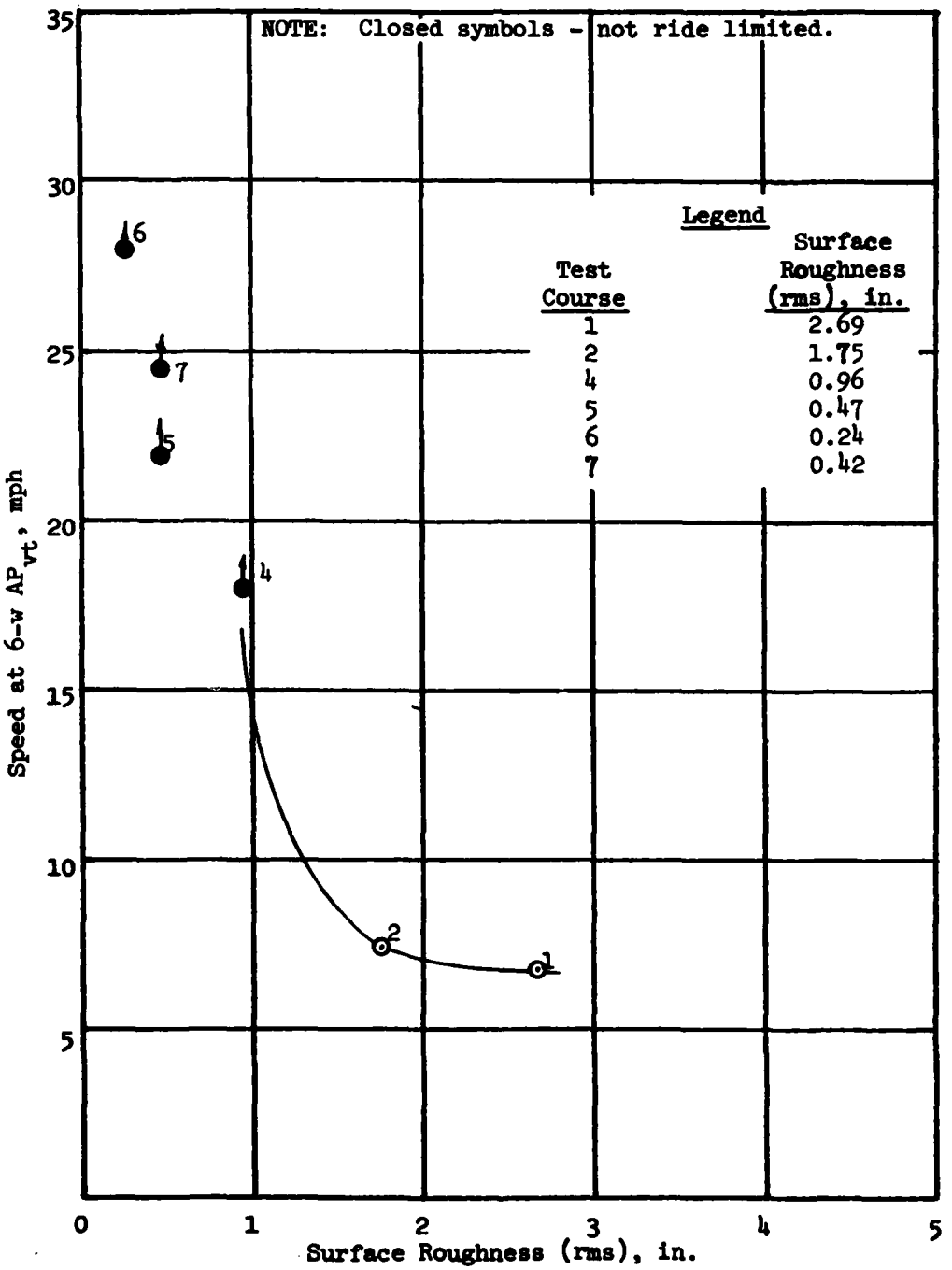
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, LEFT CARGO
TROOP SEAT, EMPTY, 35-PSI TIRE PRESSURE

PLATE 44



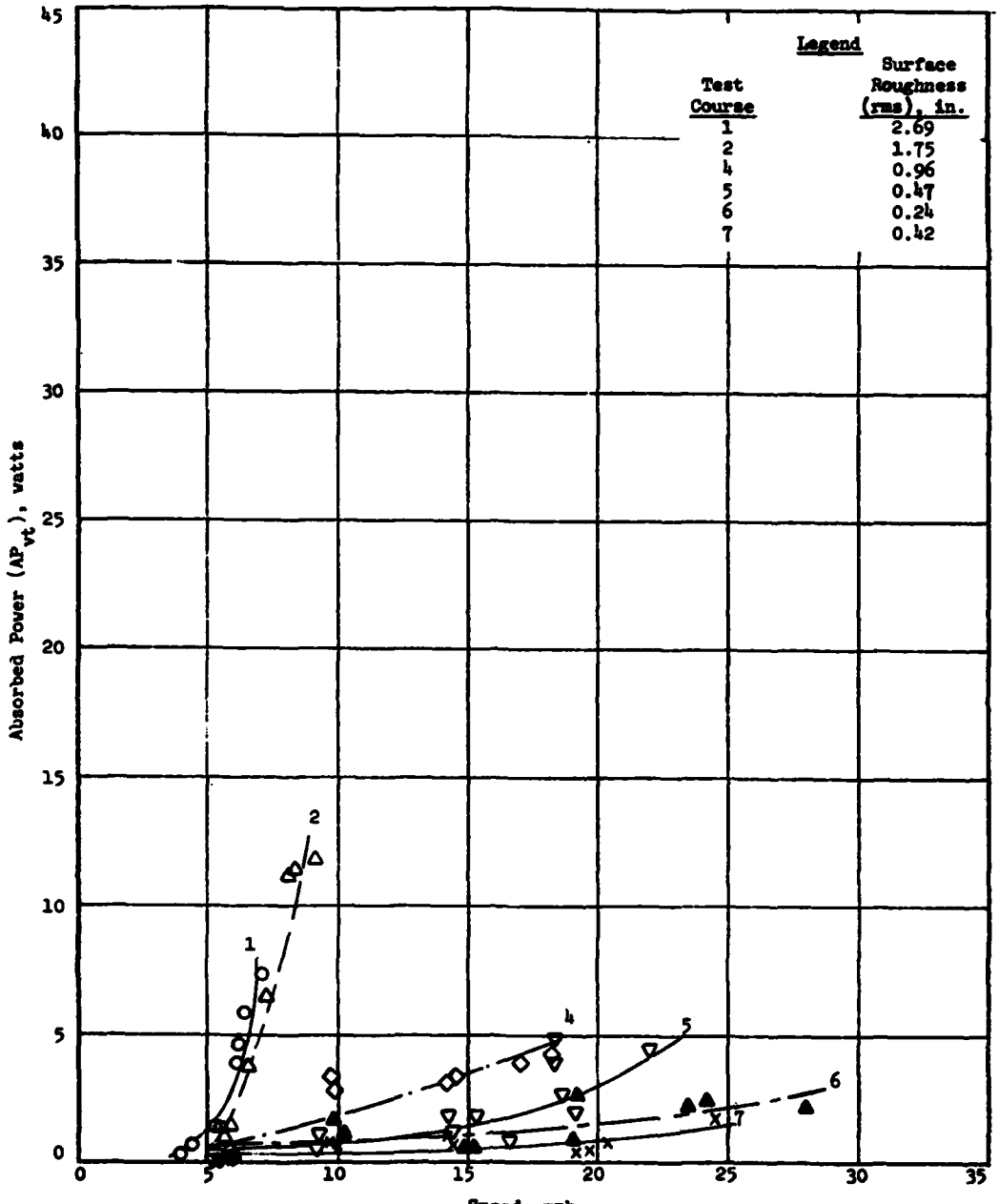
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, LEFT CARGO
TROOP SEAT, EMPTY, 35-PSI TIRE PRESSURE

PLATE 45



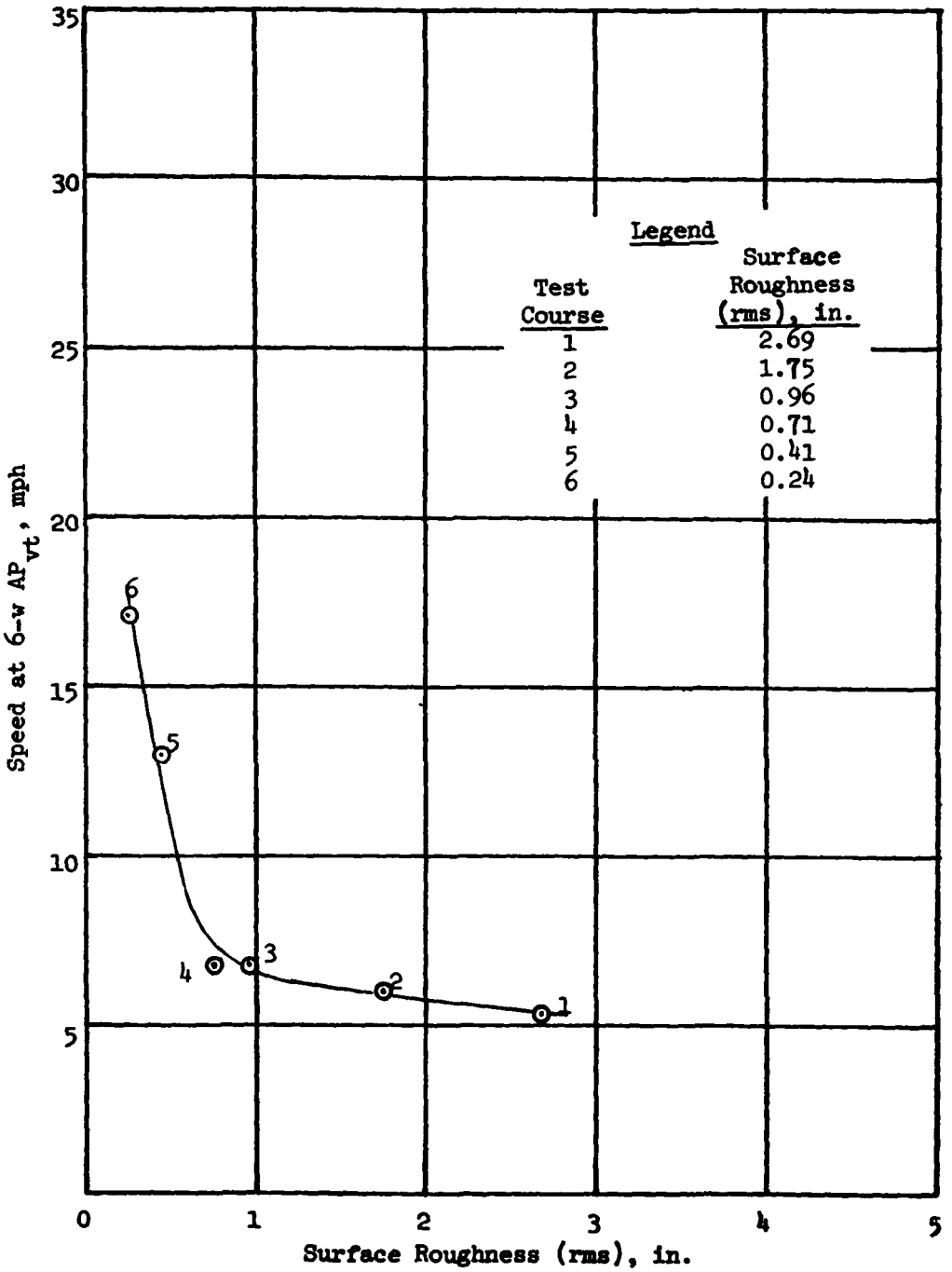
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, LEFT CARGO
TROOP SEAT, LOADED, 35-PSI TIRE PRESSURE

PLATE 46



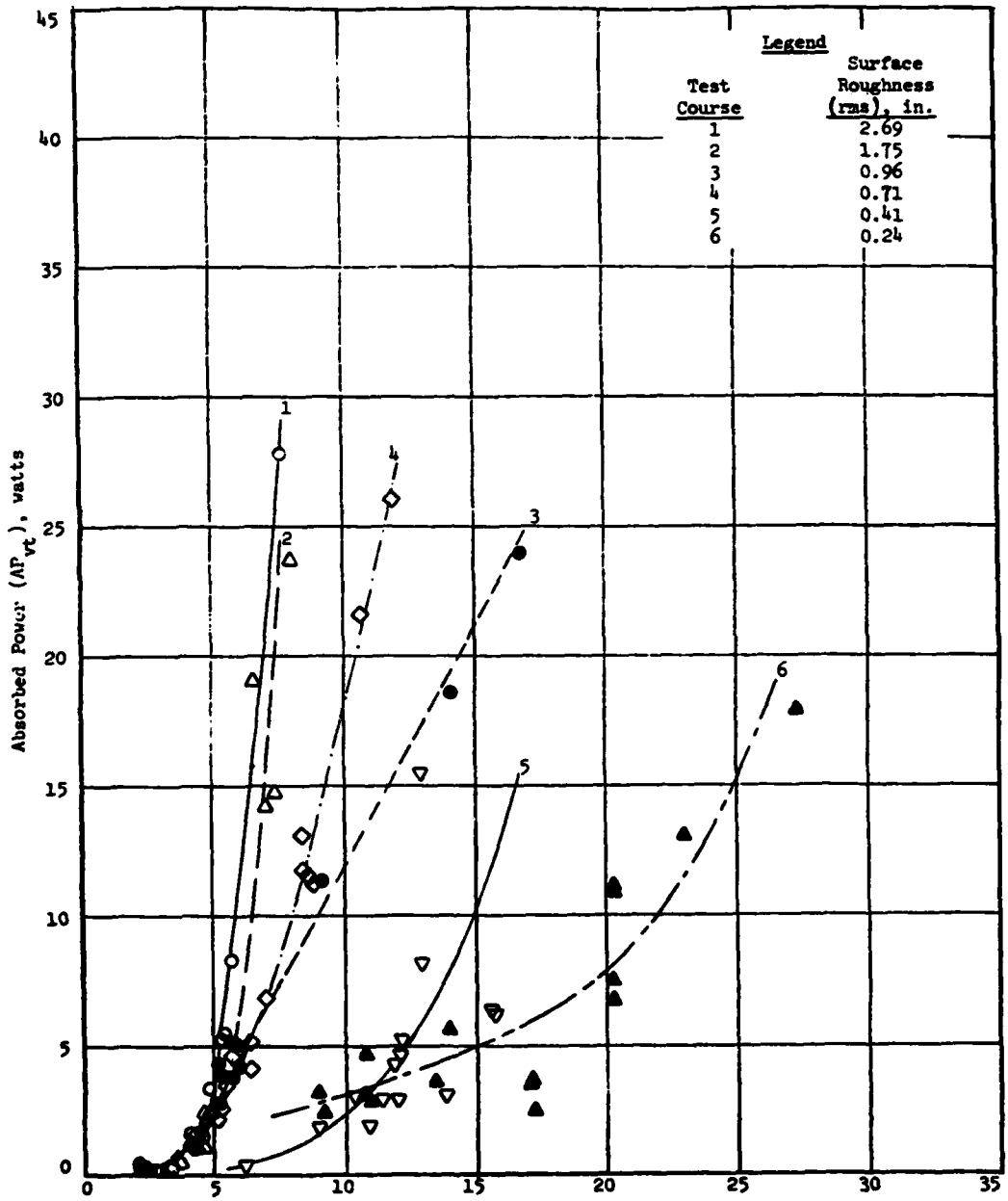
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, LEFT CARGO
TROOP SEAT, LOADED, 35-PSI TIRE PRESSURE

PLATE 47



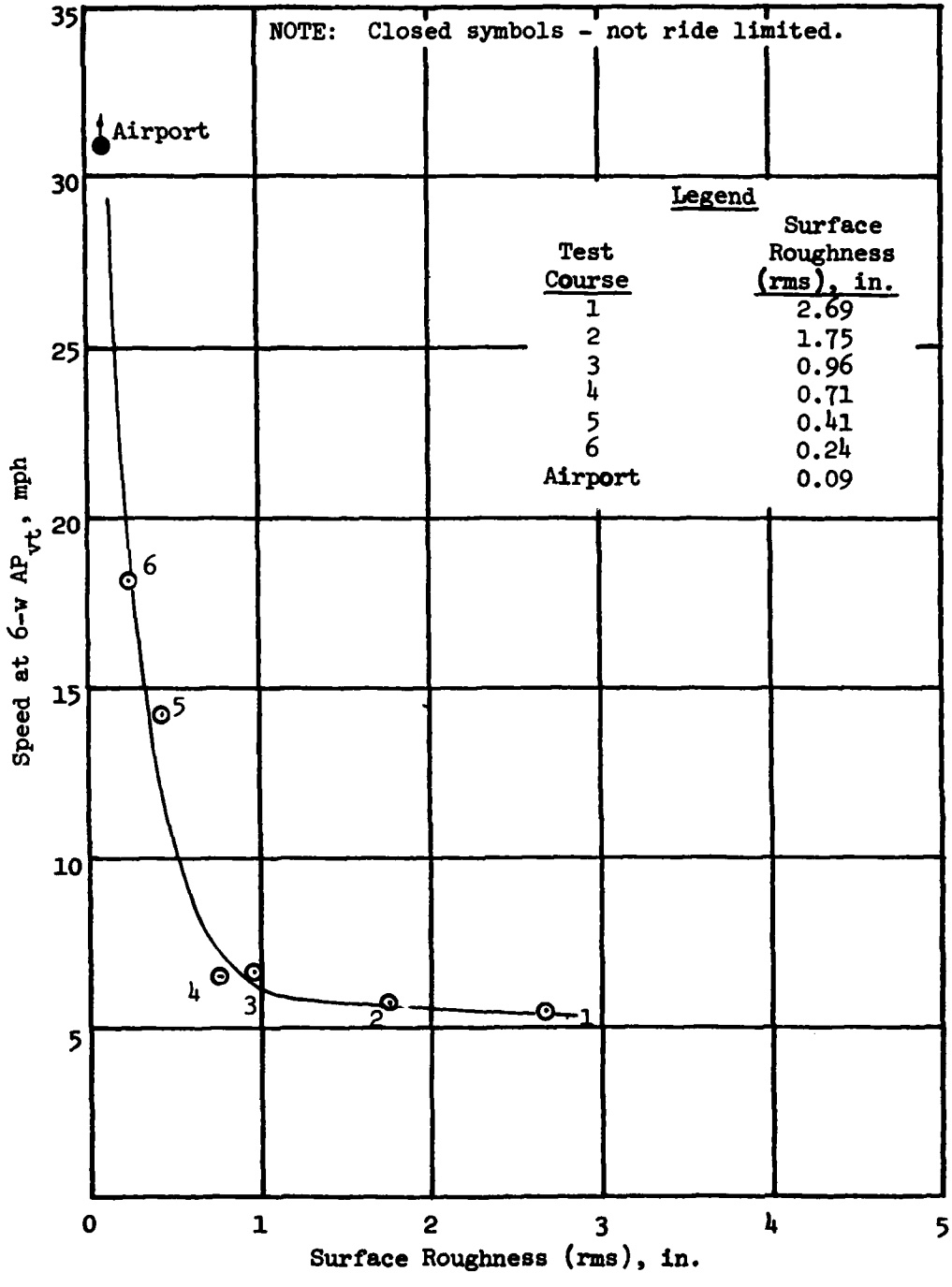
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED, EMPTY
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 48



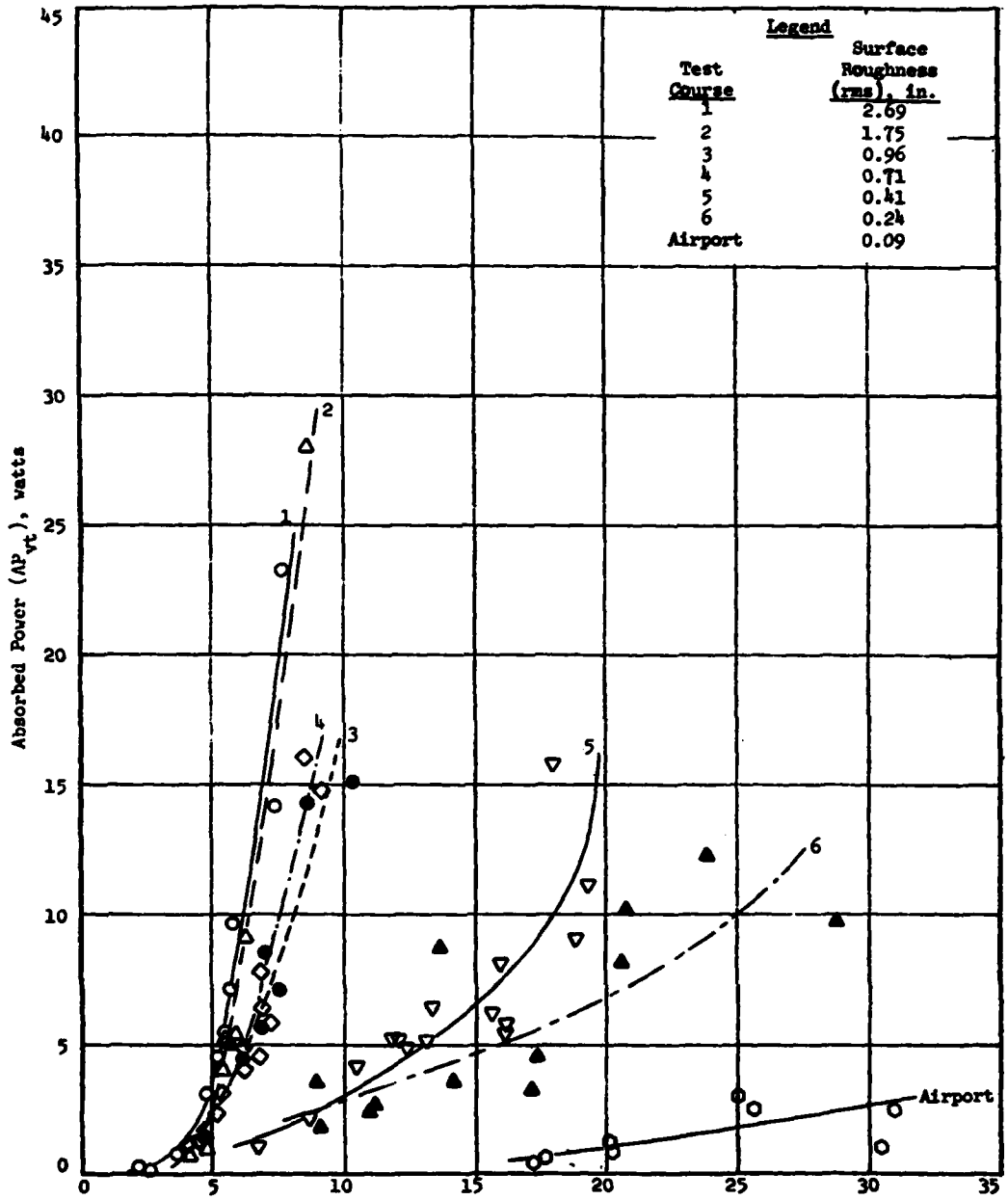
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED, EMPTY
55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 49



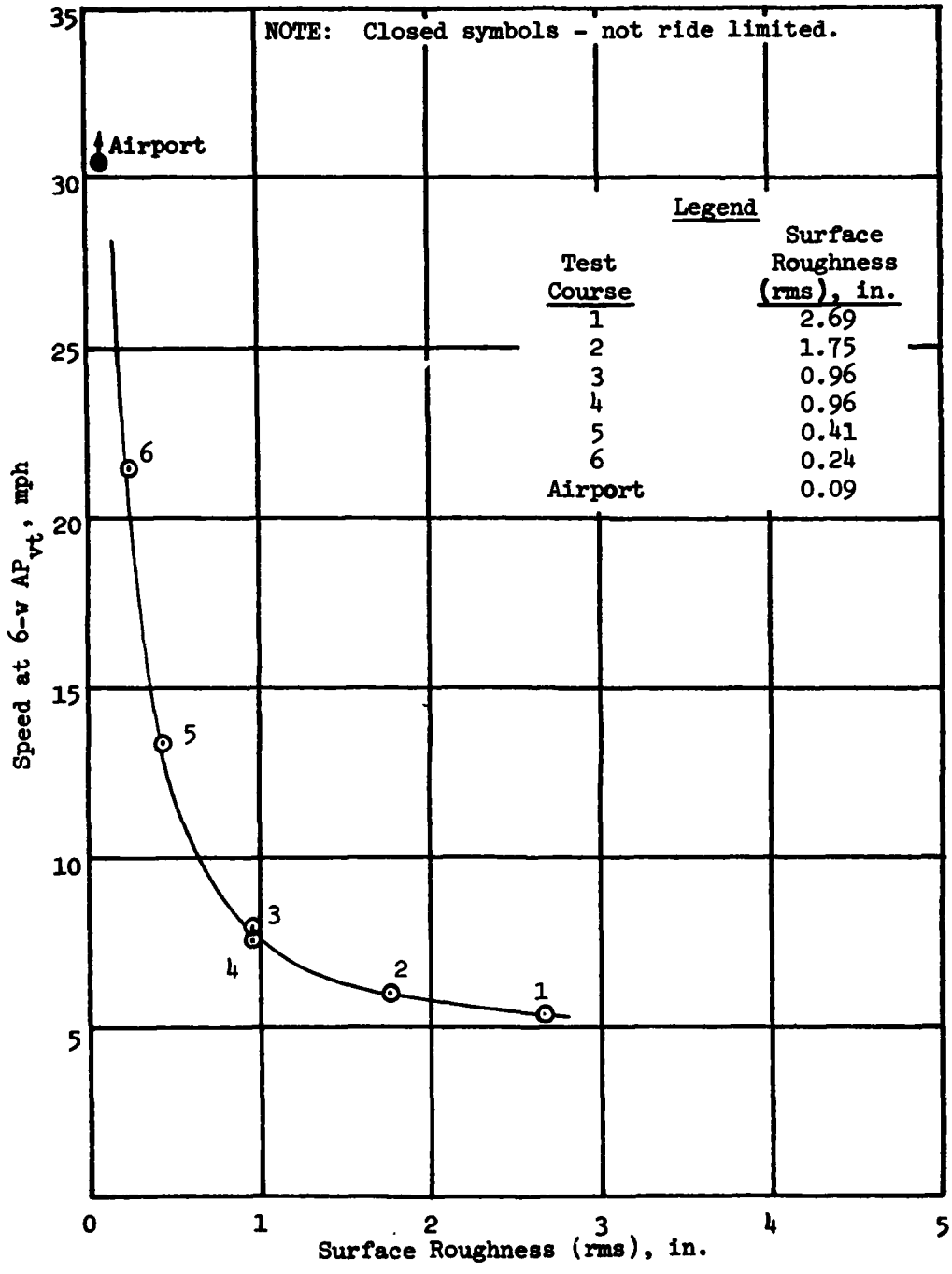
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED
EMPTY, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 50



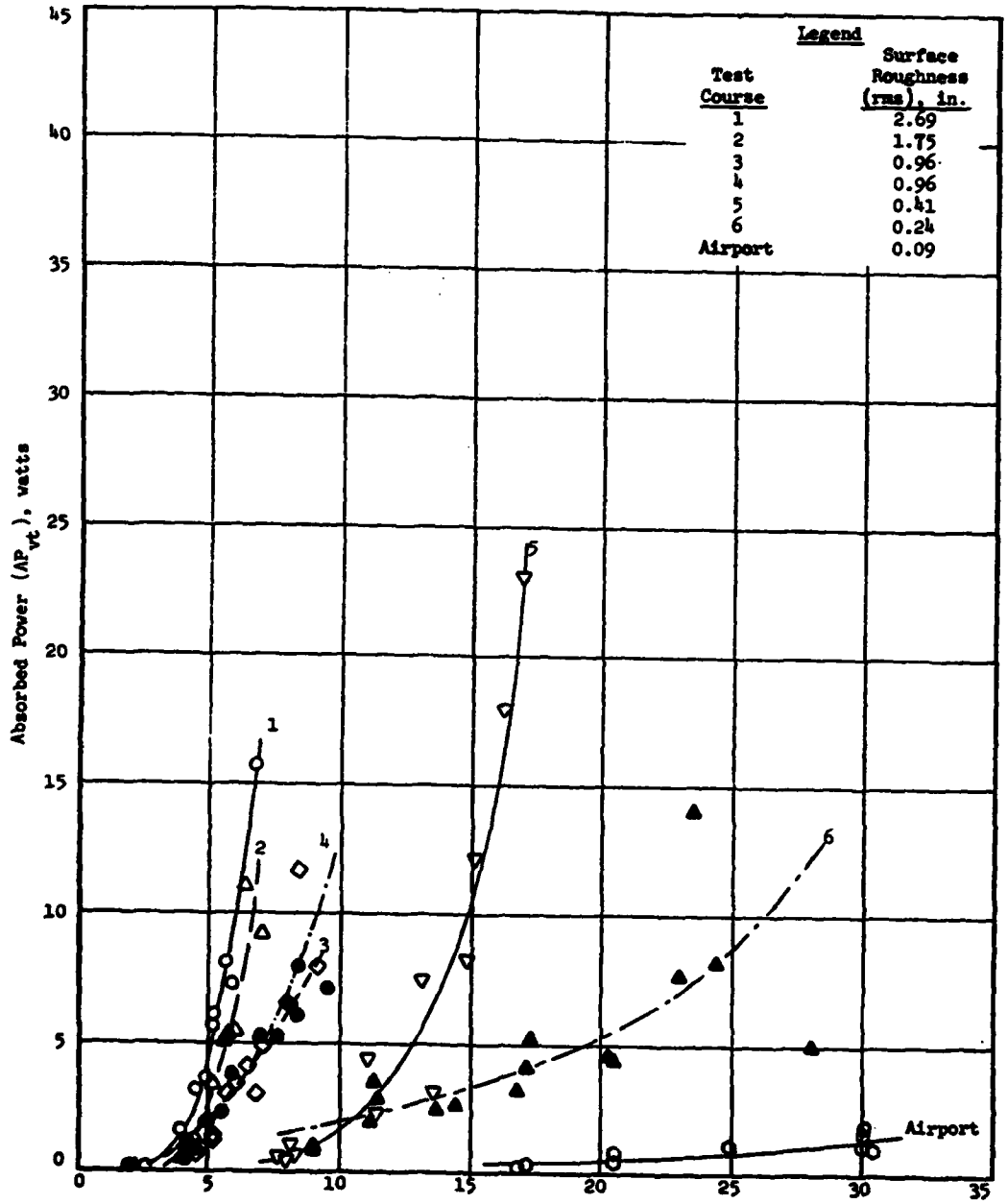
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED
EMPTY, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 51



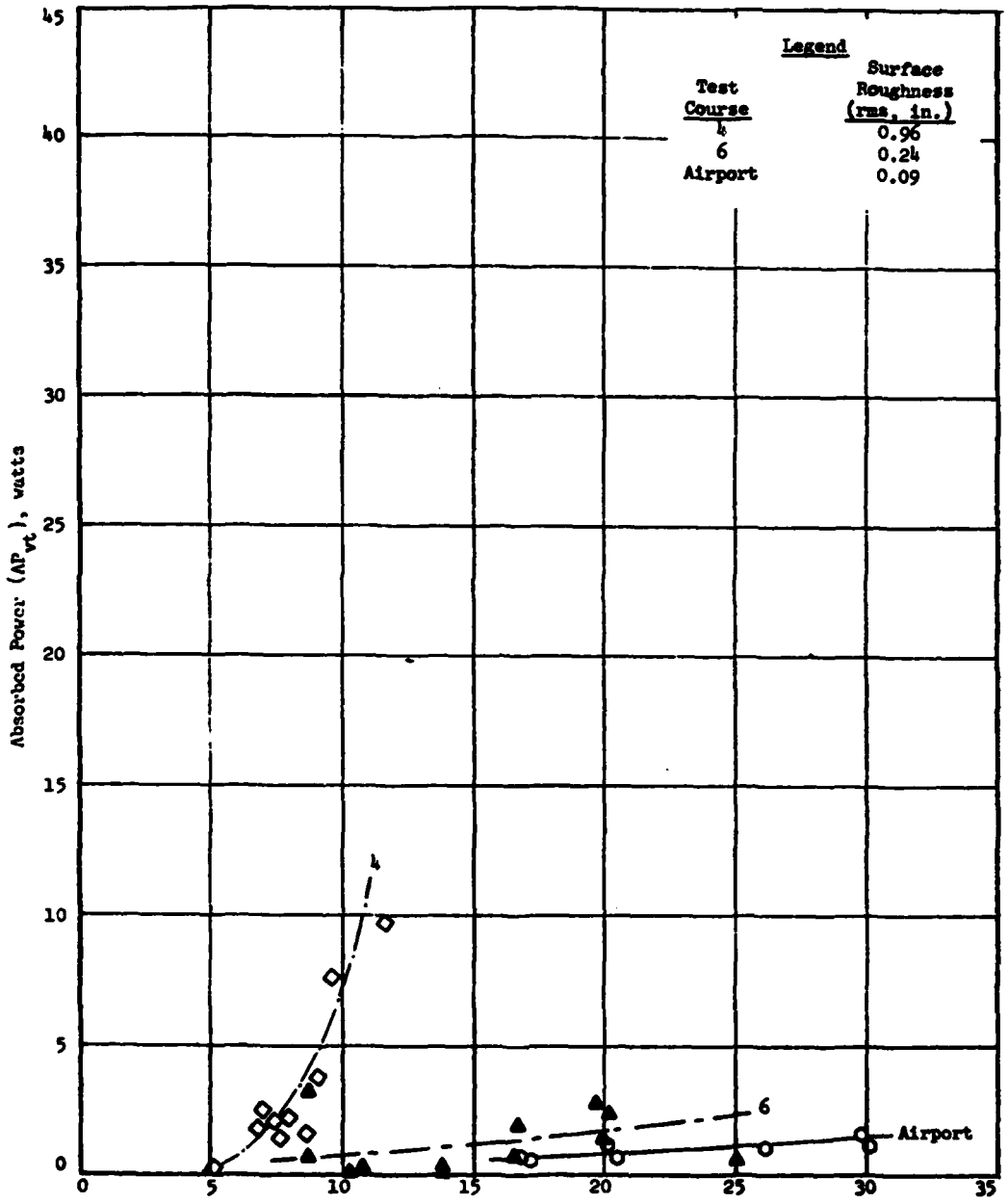
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED
EMPTY, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 52



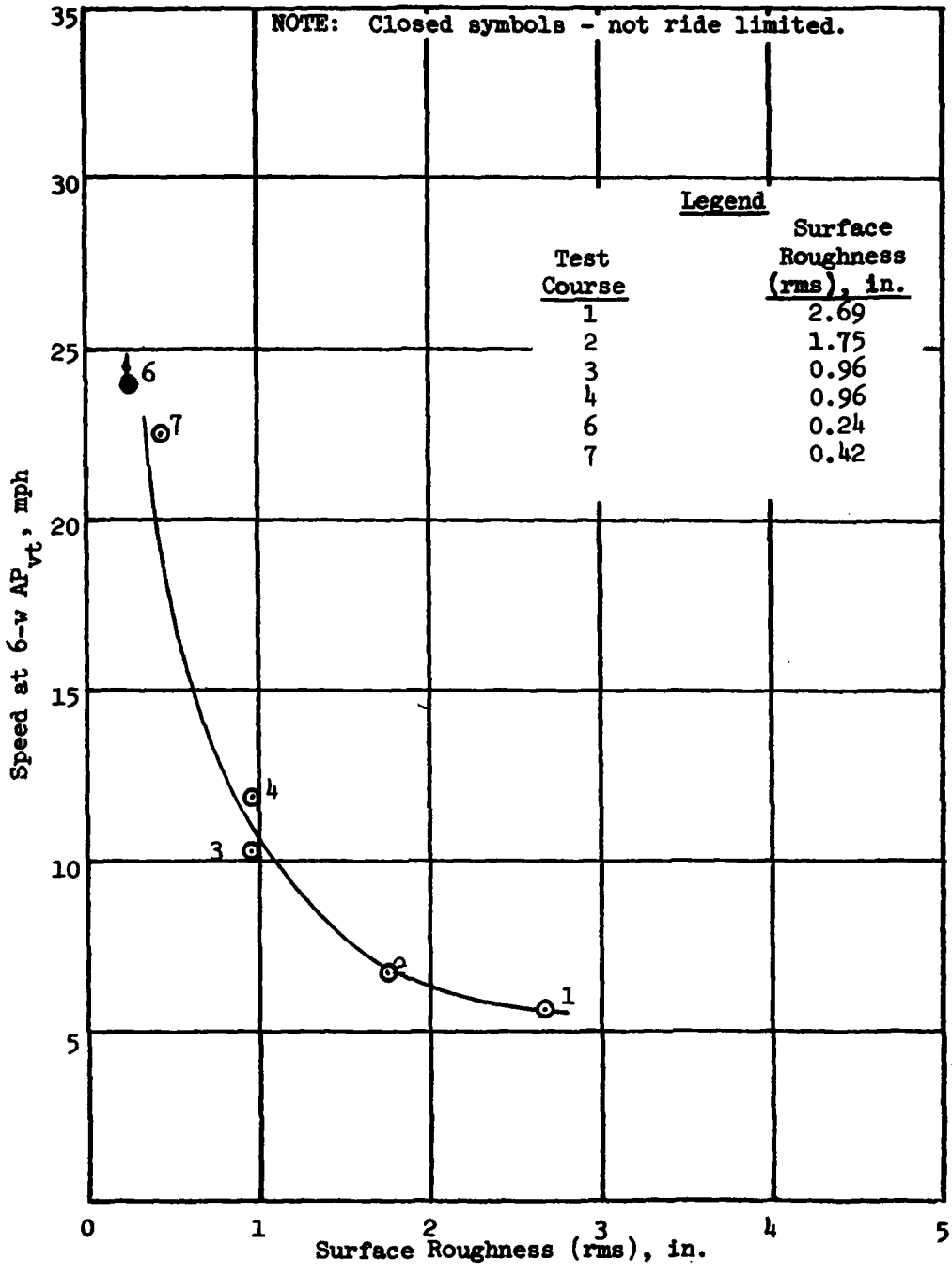
RIDE RESPONSE
FANECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED
EMPTY, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 53



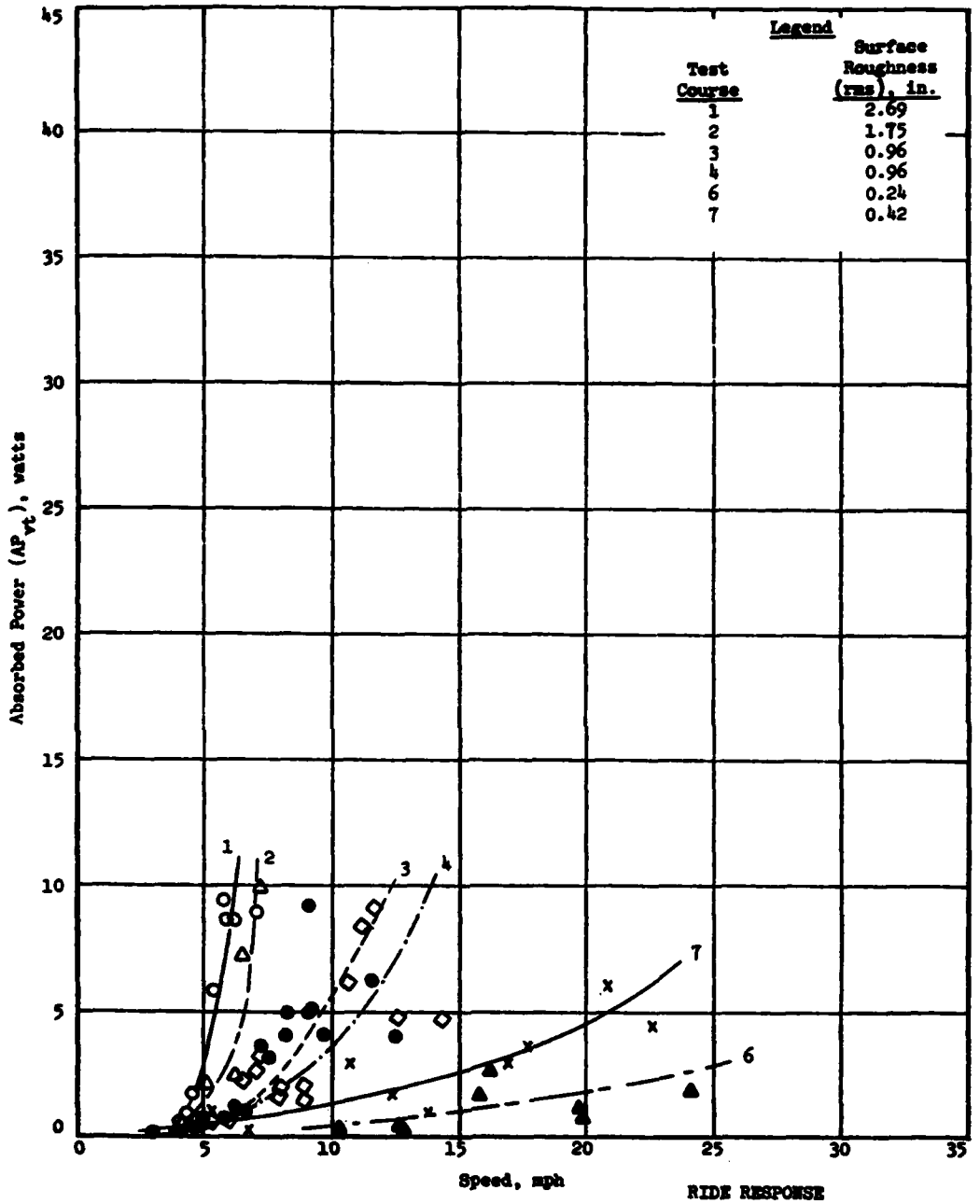
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED
LOADED, 55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 54



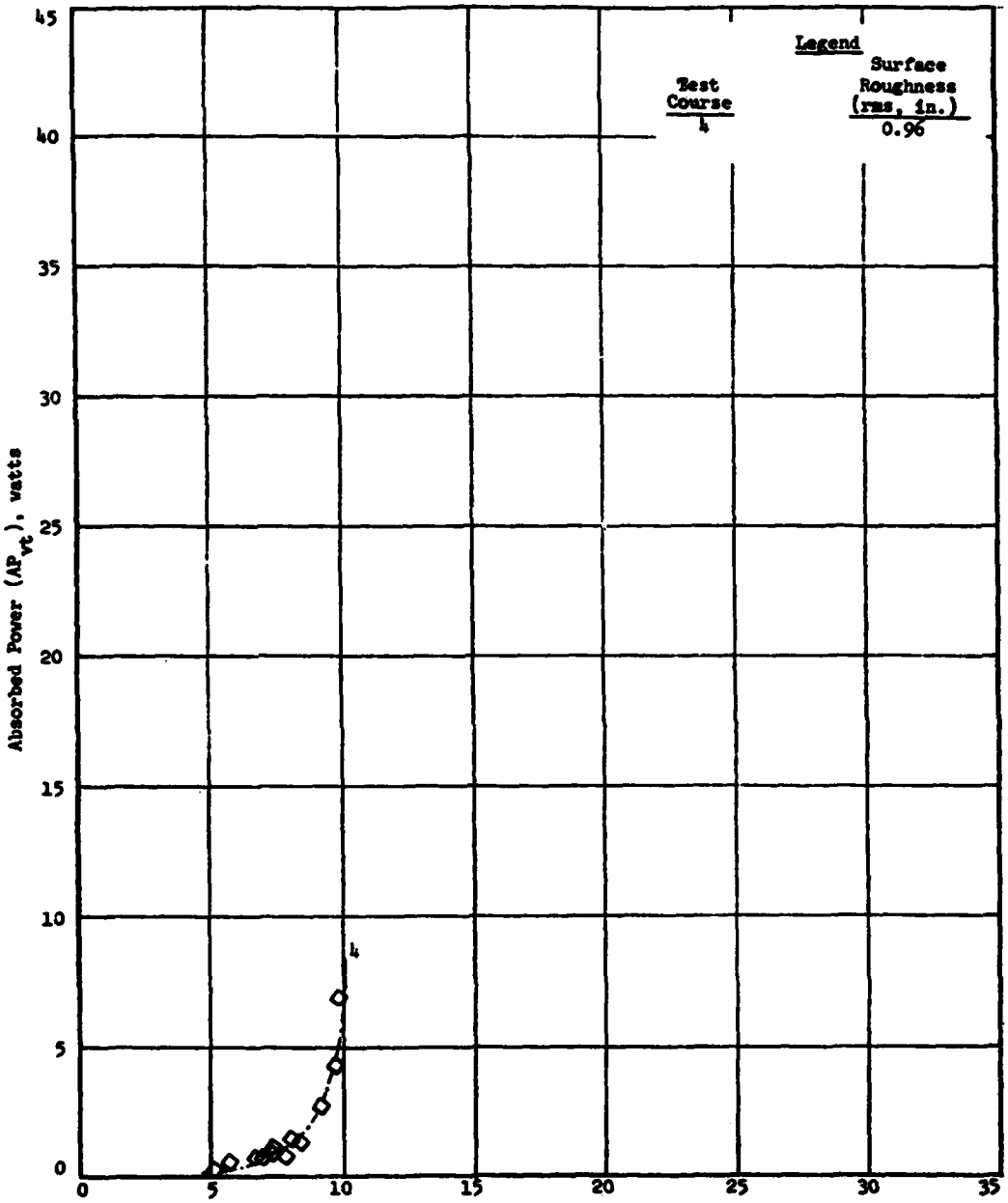
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED
LOADED, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 55



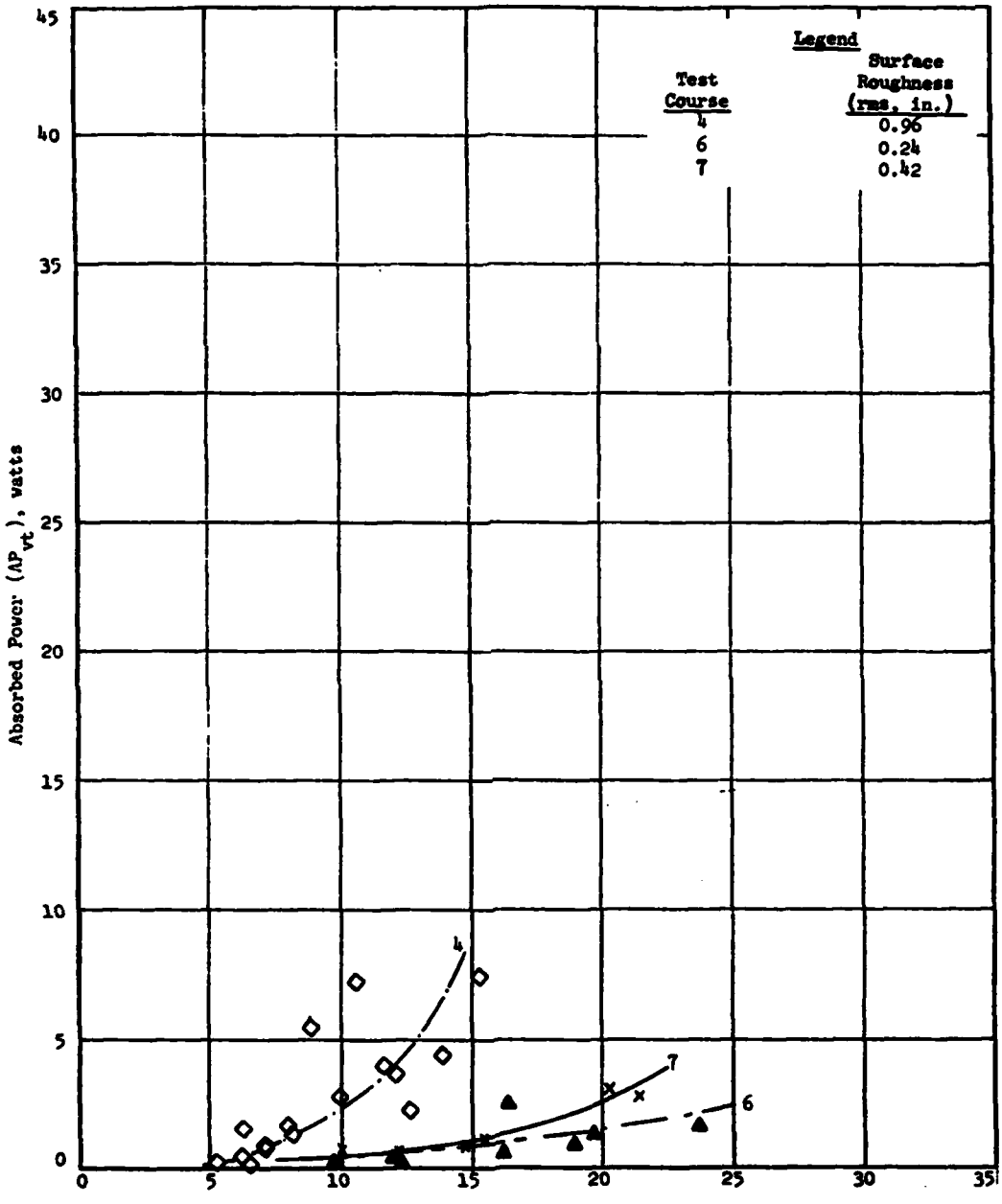
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED
LOADED, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 56



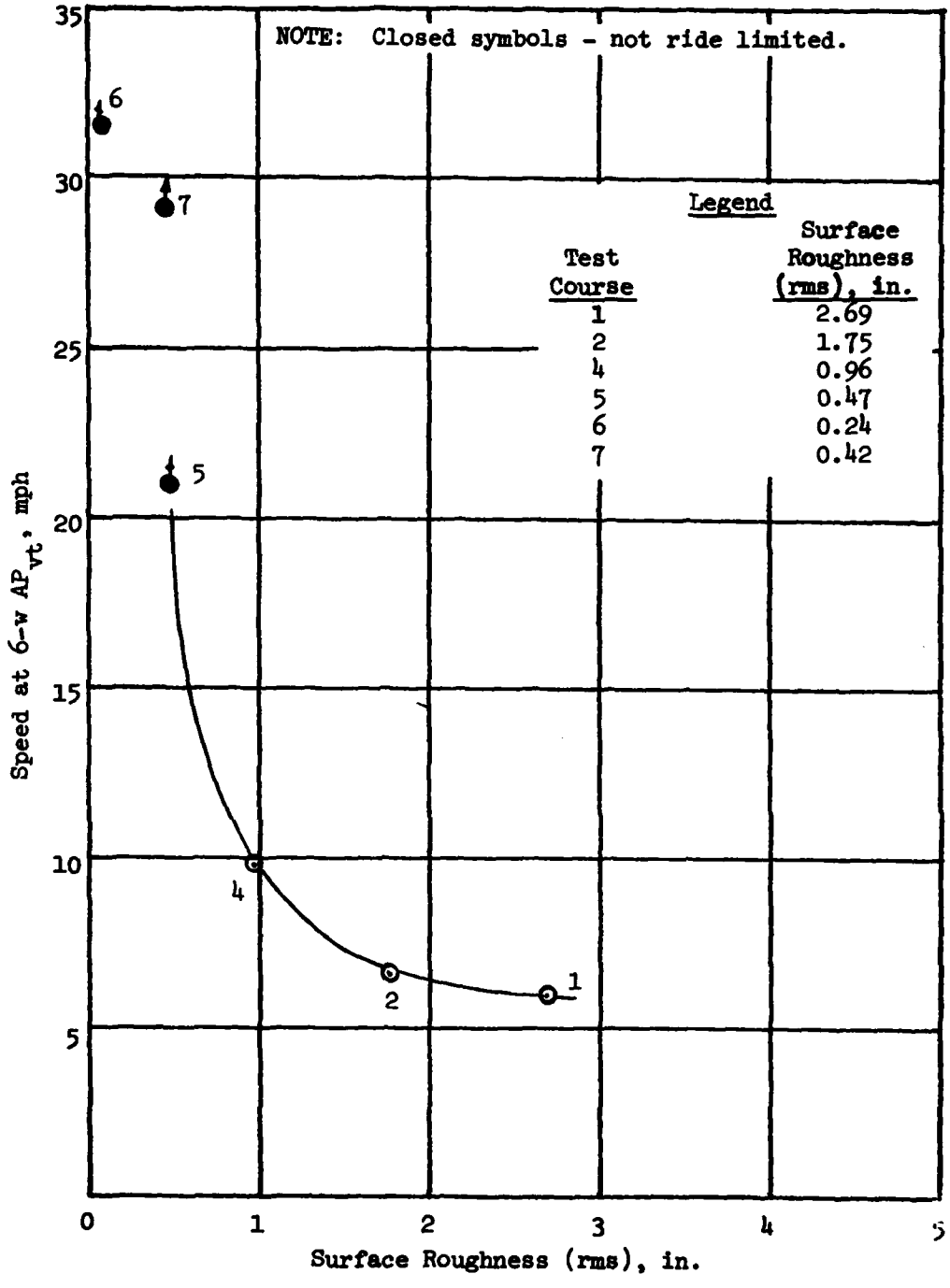
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED, LOADED
45-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 57



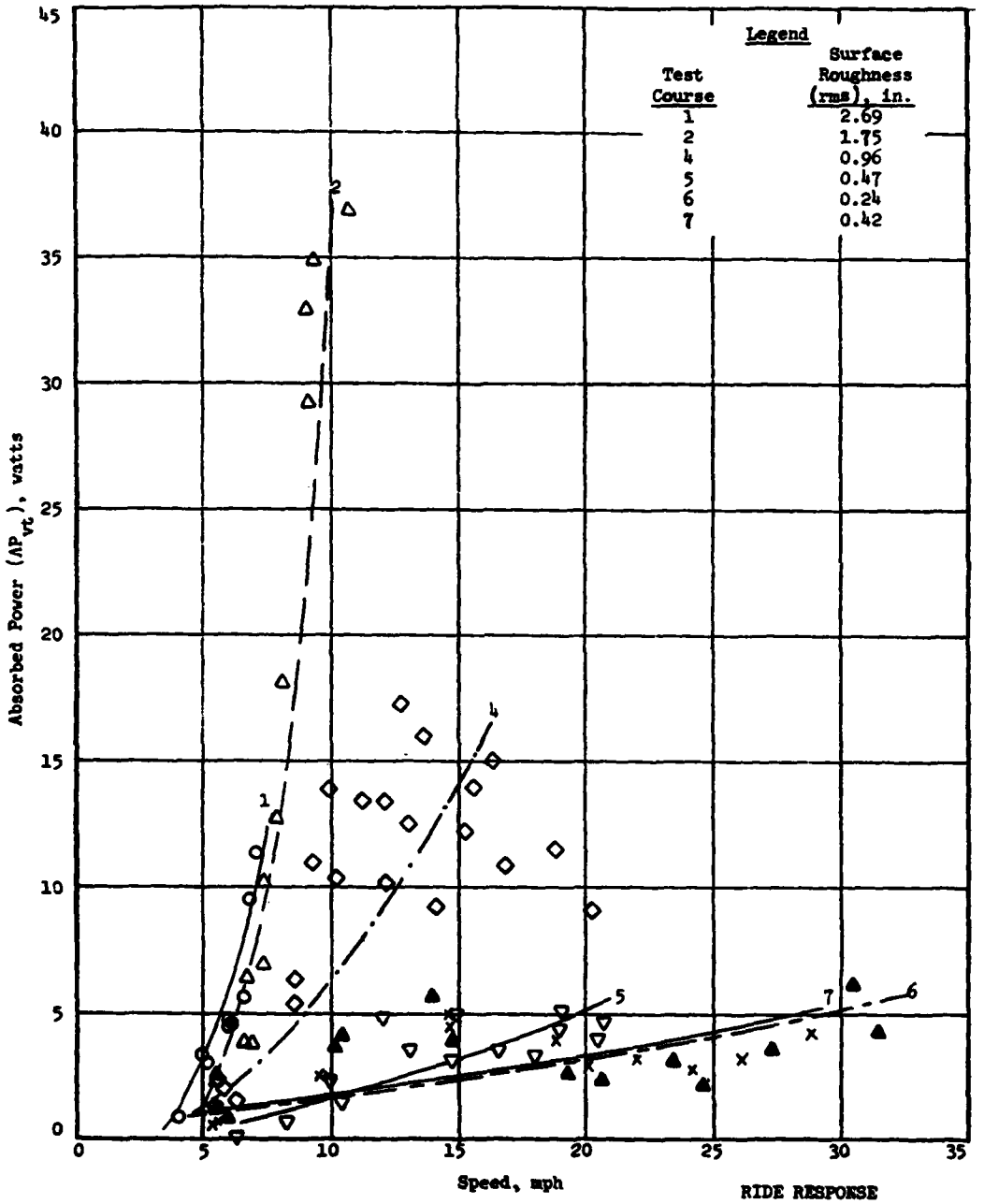
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, RIGHT CARGO, STEEL BED
LOADED, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 58



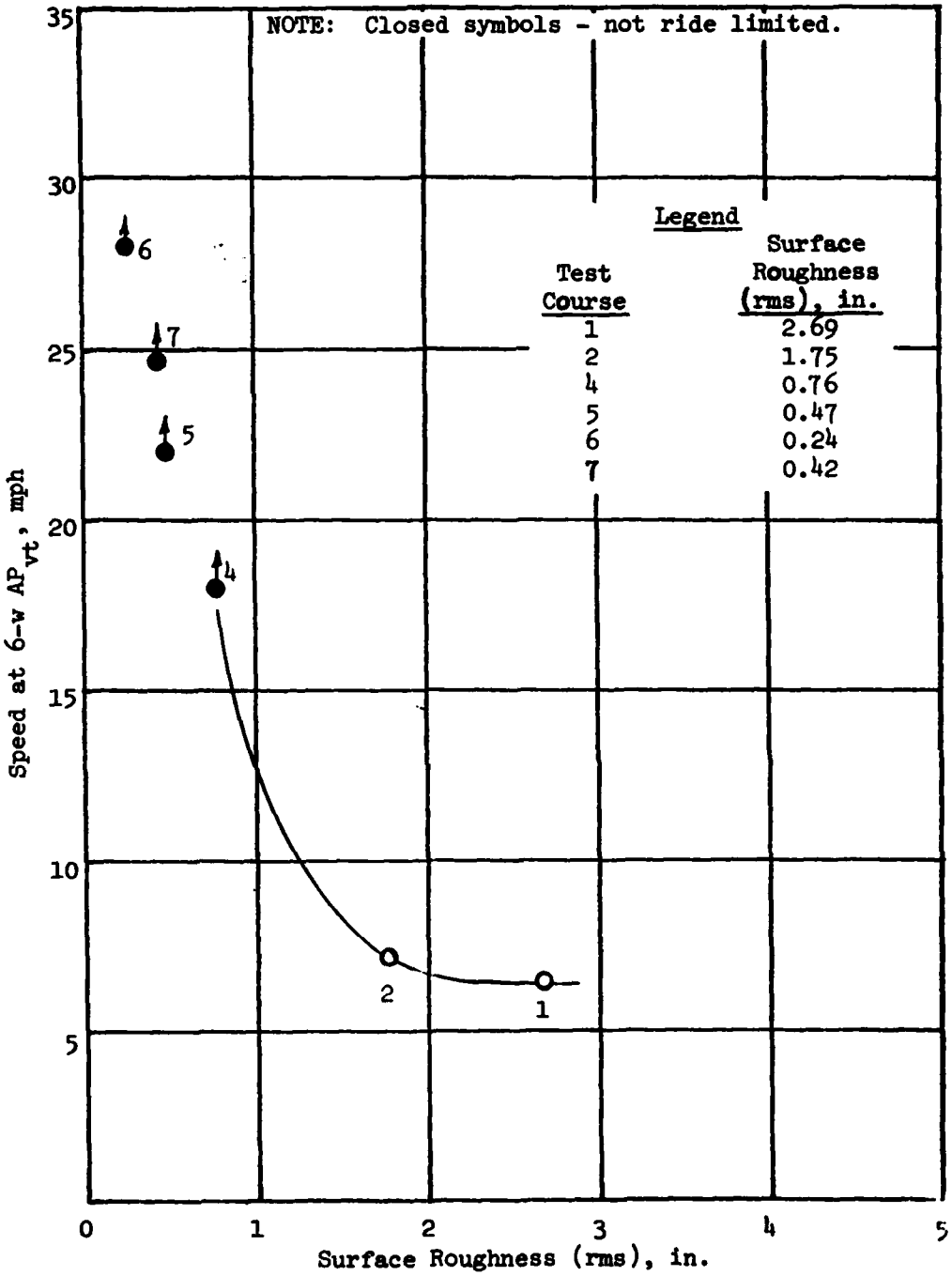
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, RIGHT CARGO, STEEL
BED, EMPTY, 35-PSI TIRE PRESSURE

PLATE 59



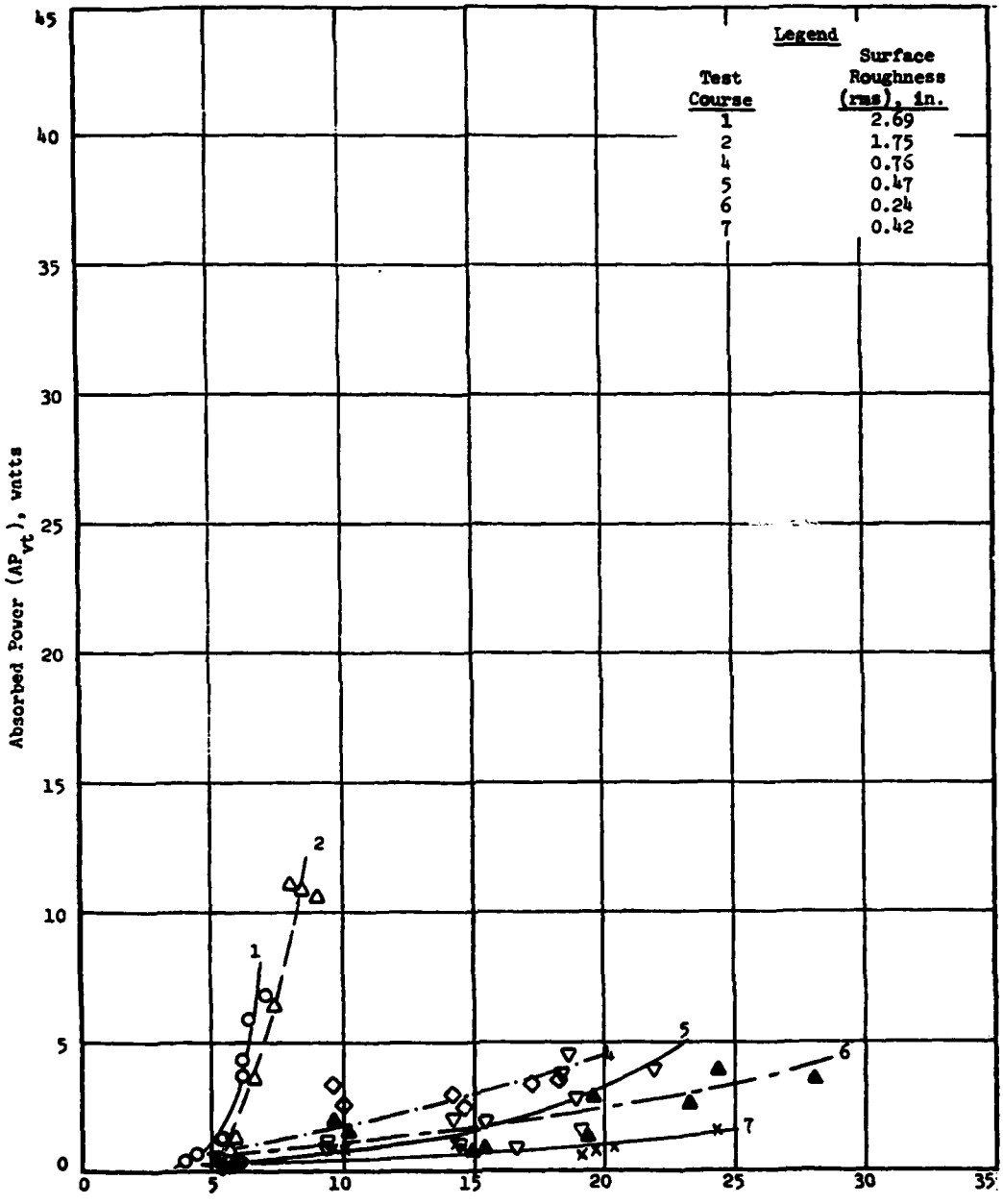
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, RIGHT CARGO, STEEL
BED, EMPTY, 35-PSI TIRE PRESSURE

PLATE 60



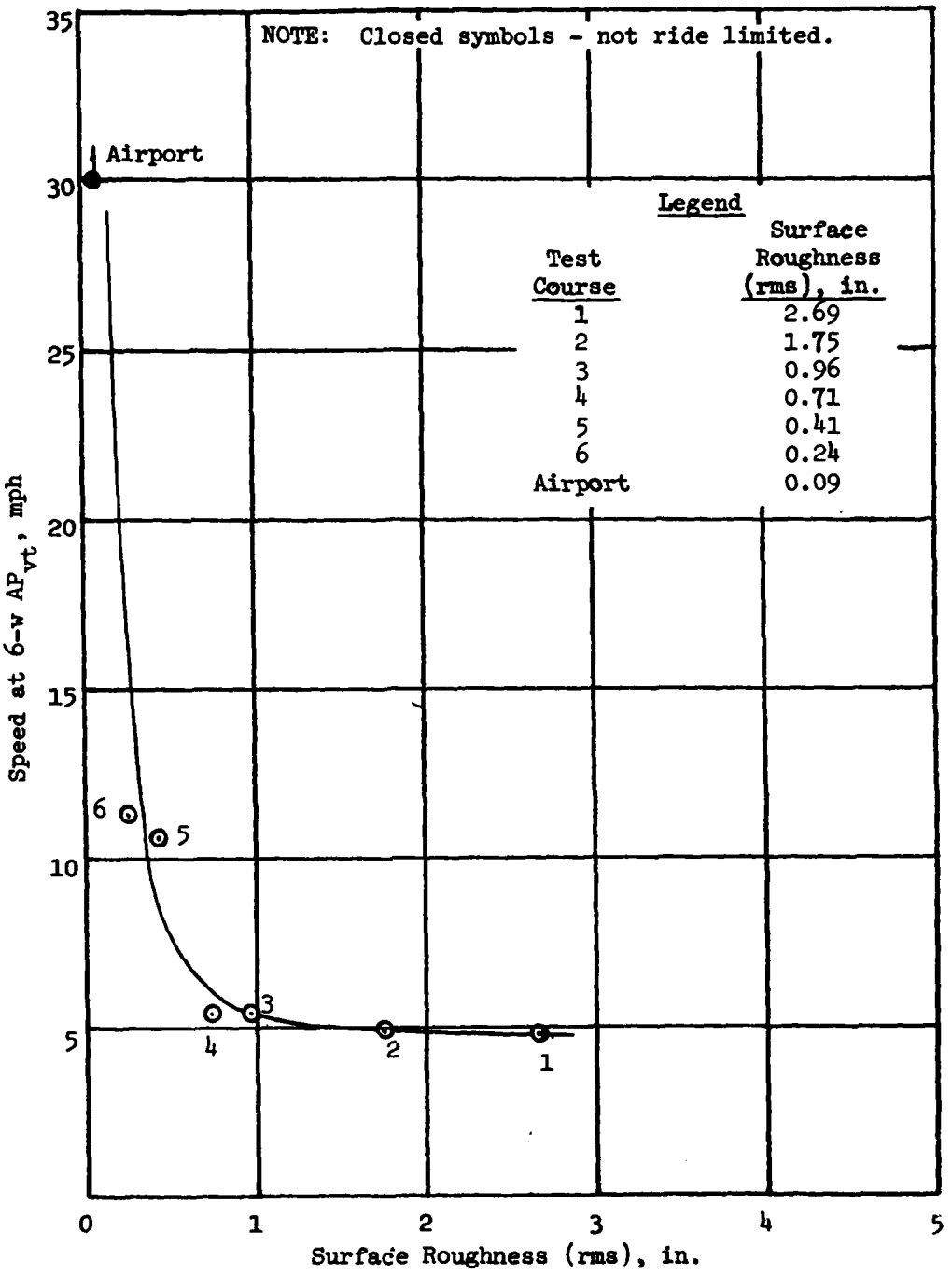
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, RIGHT CARGO, STEEL
BED, LOADED, 35-PSI TIRE PRESSURE

PLATE 61



RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, RIGHT CARGO, STEEL
BED, LOADED, 35-PSI TIRE PRESSURE

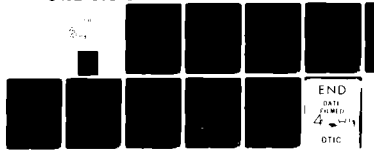
PLATE 62

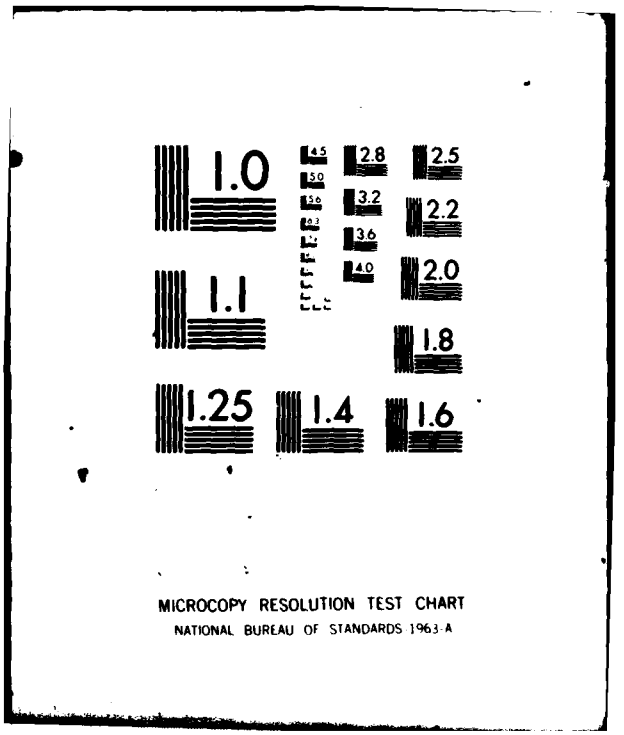


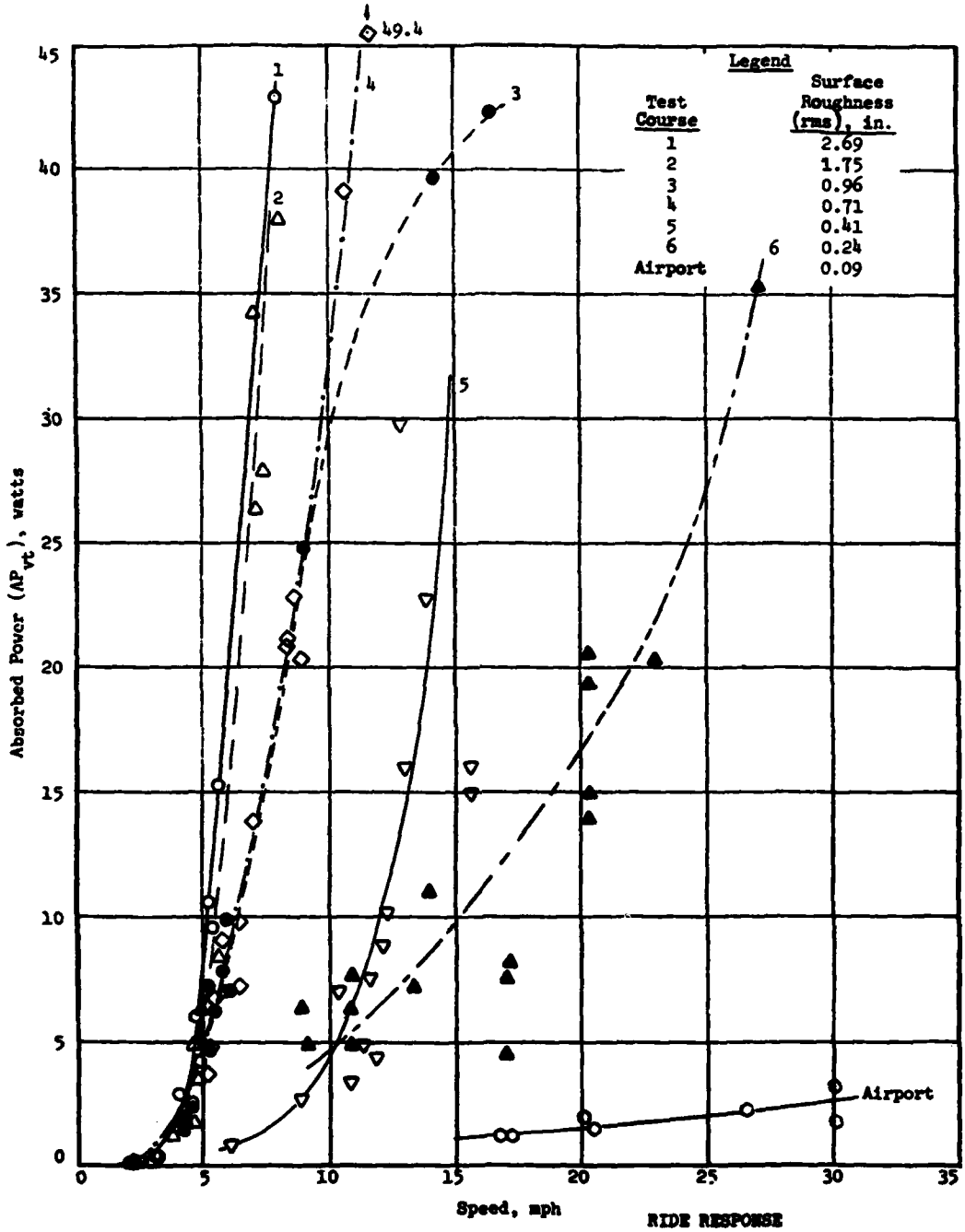
RIDE PERFORMANCE
FAMECE·DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
EMPTY, 55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 63

AD-A096 261 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/G 13/6
RIDE TEST RESULTS FOR THE FAMECE DUMPER AND COMPARISON VEHICLES--ETC(U)
JAN 81 W E WILLOUGHBY
UNCLASSIFIED WES/TR/GL-81-1 NL

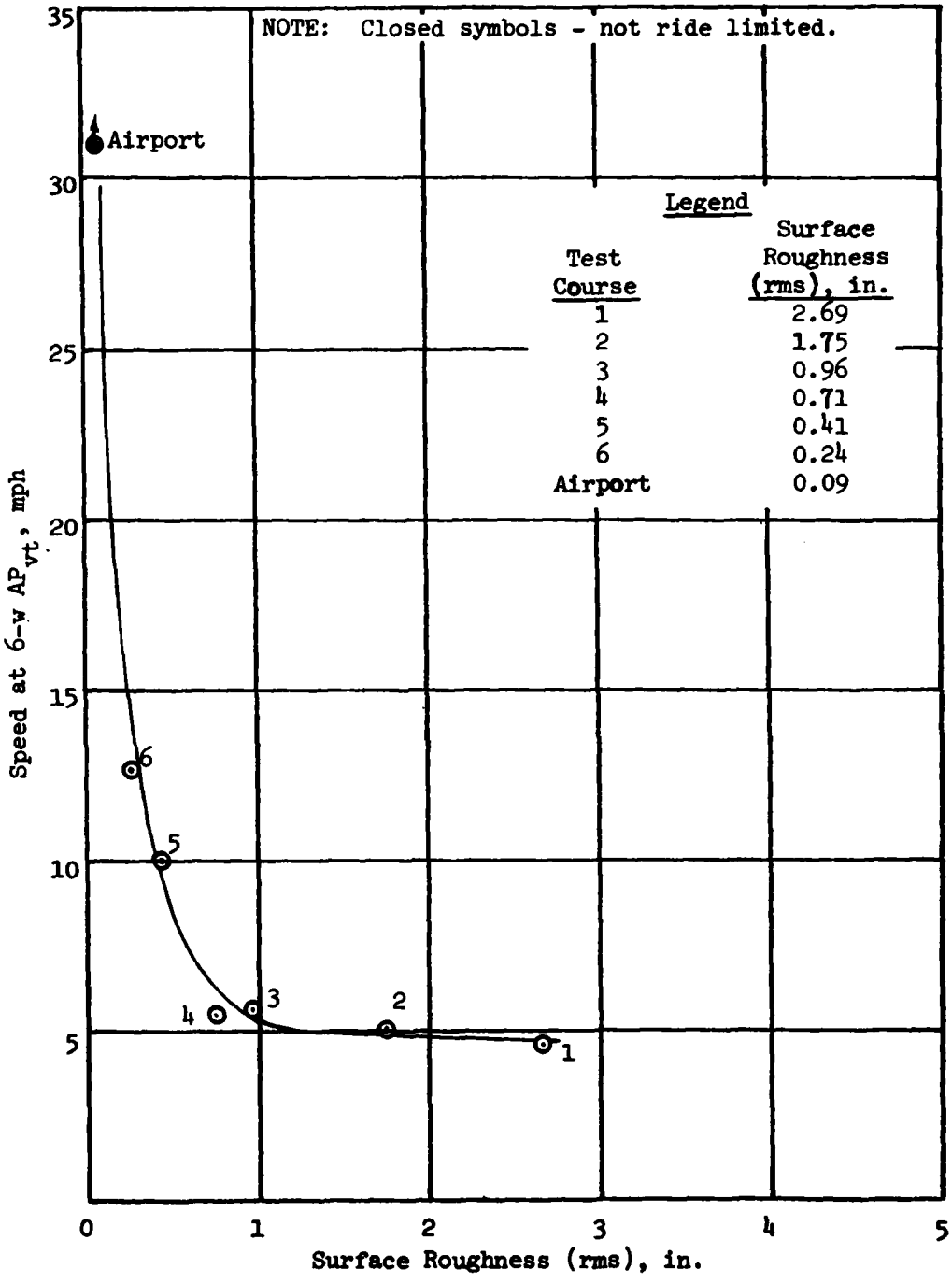



1.0
1.1
1.25
1.4
1.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A



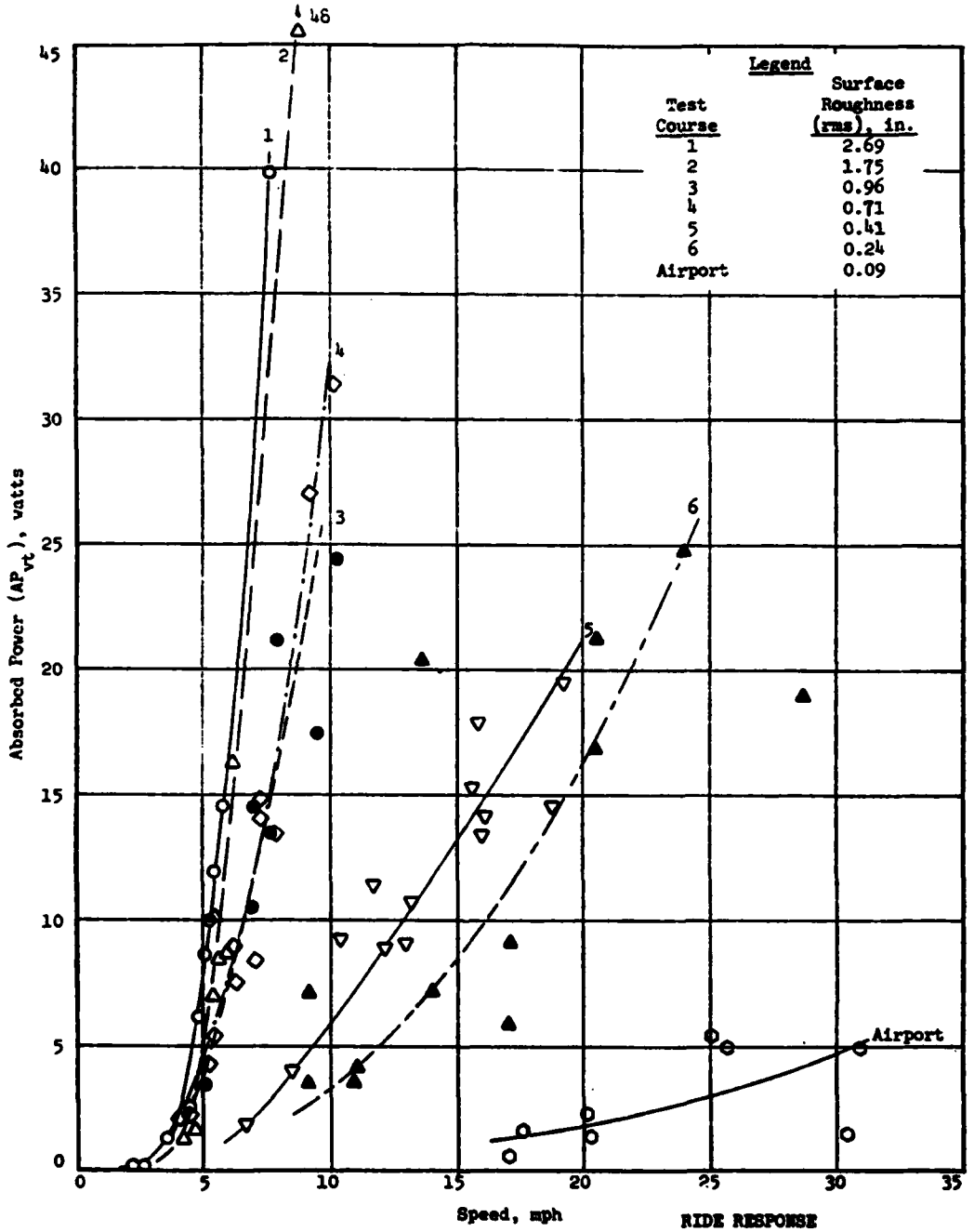
RIDE RESPONSE
FAHECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
EMPTY, 55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 64



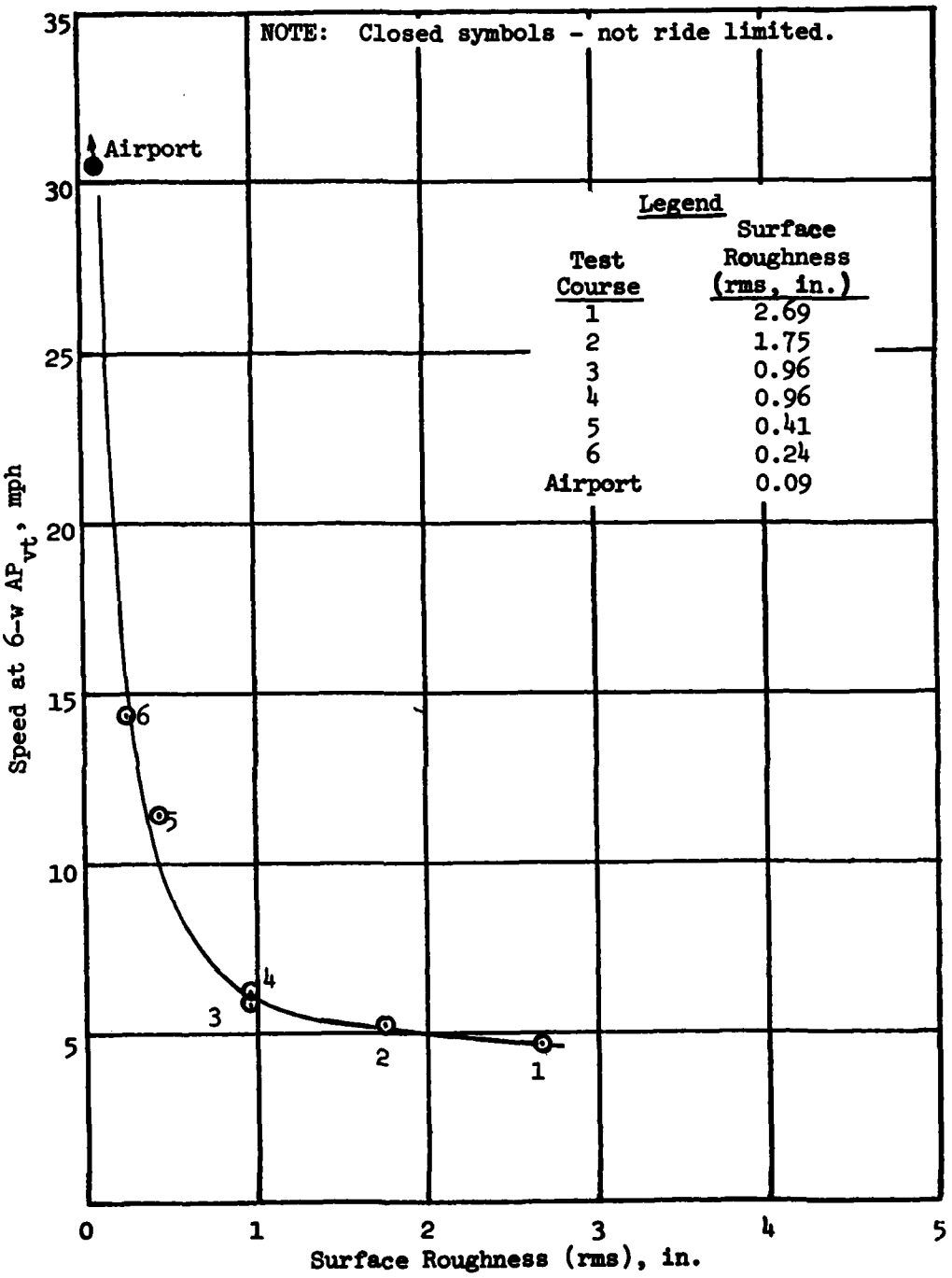
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
EMPTY, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 65



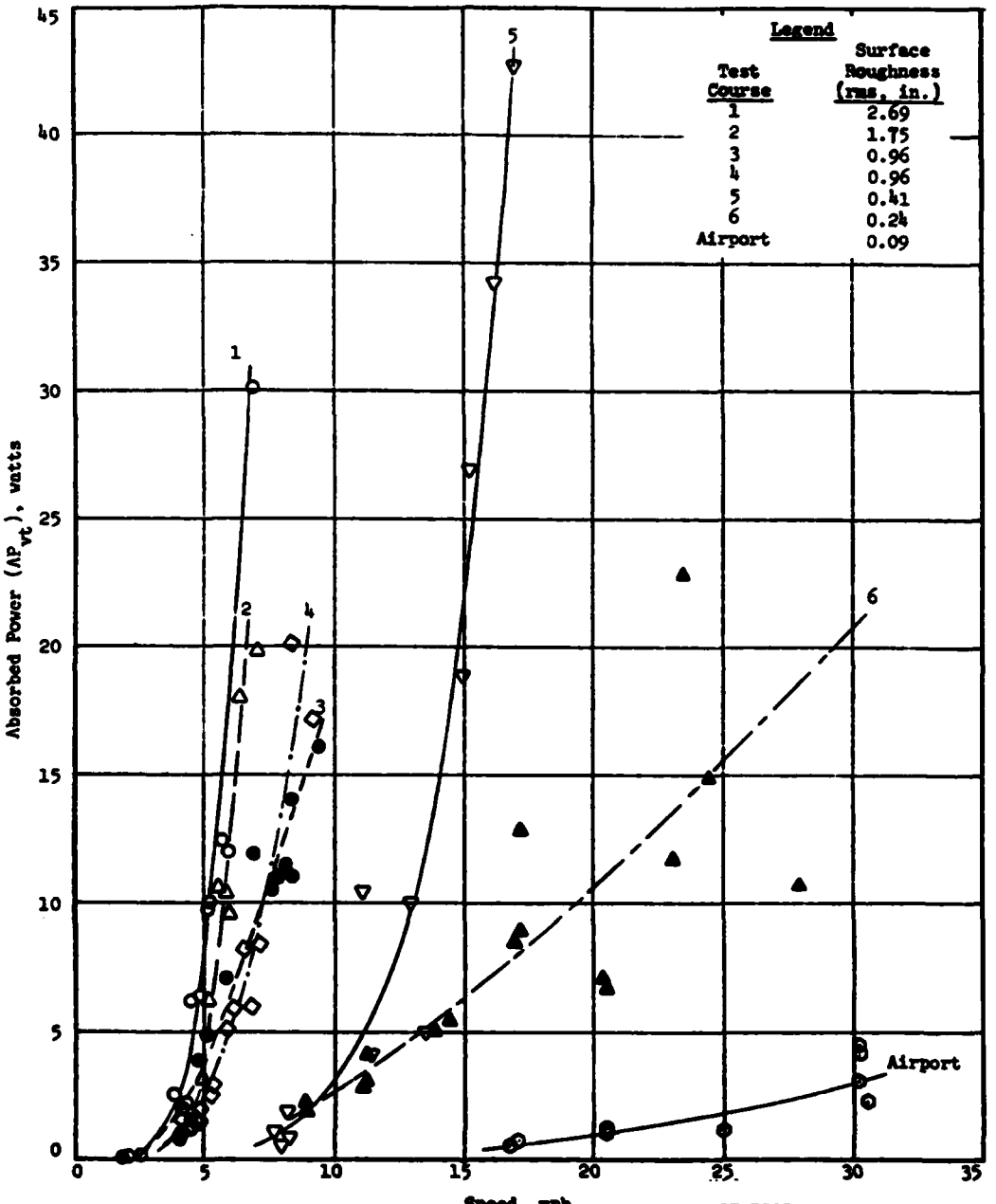
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
EMPTY, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 66



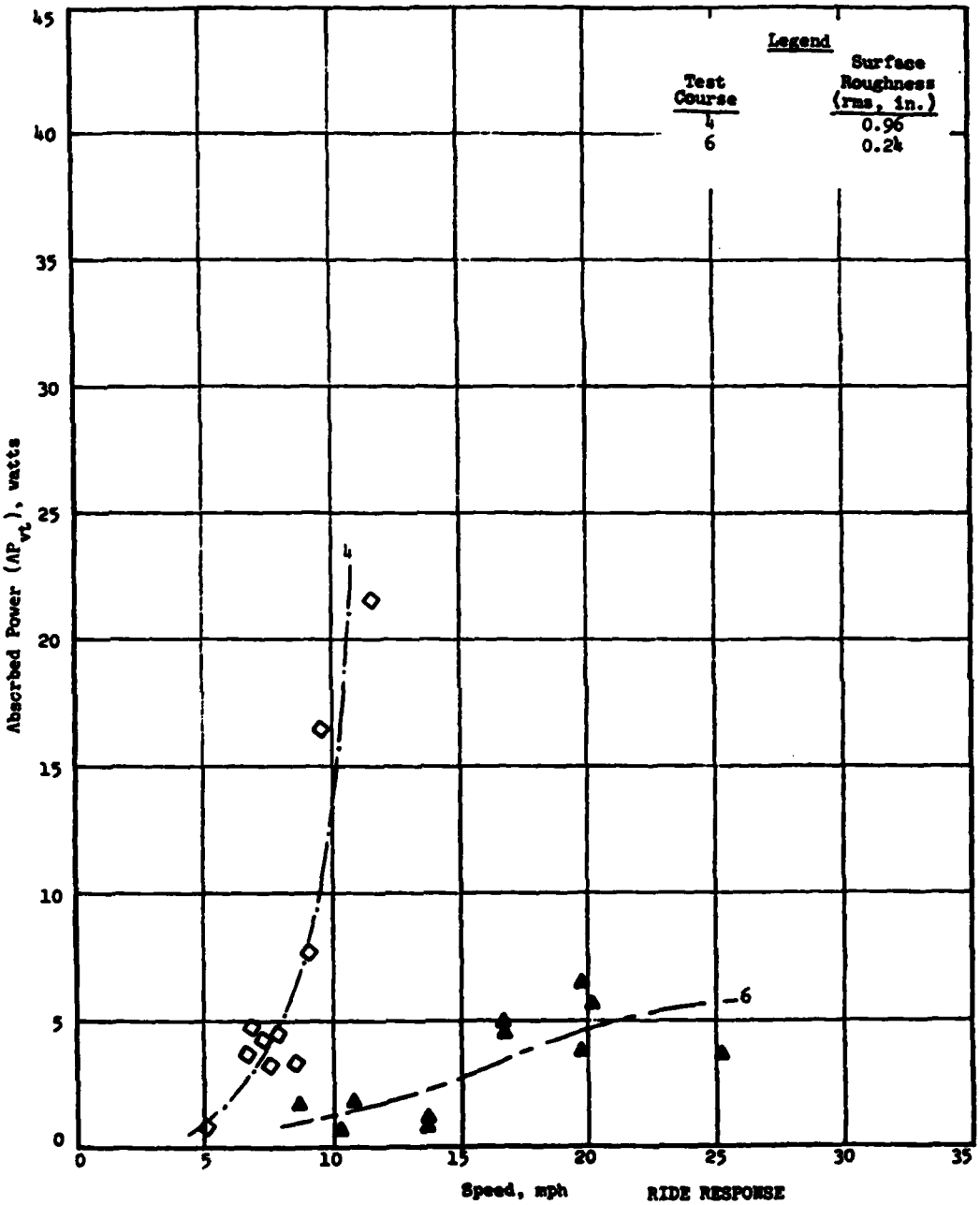
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
EMPTY, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 67



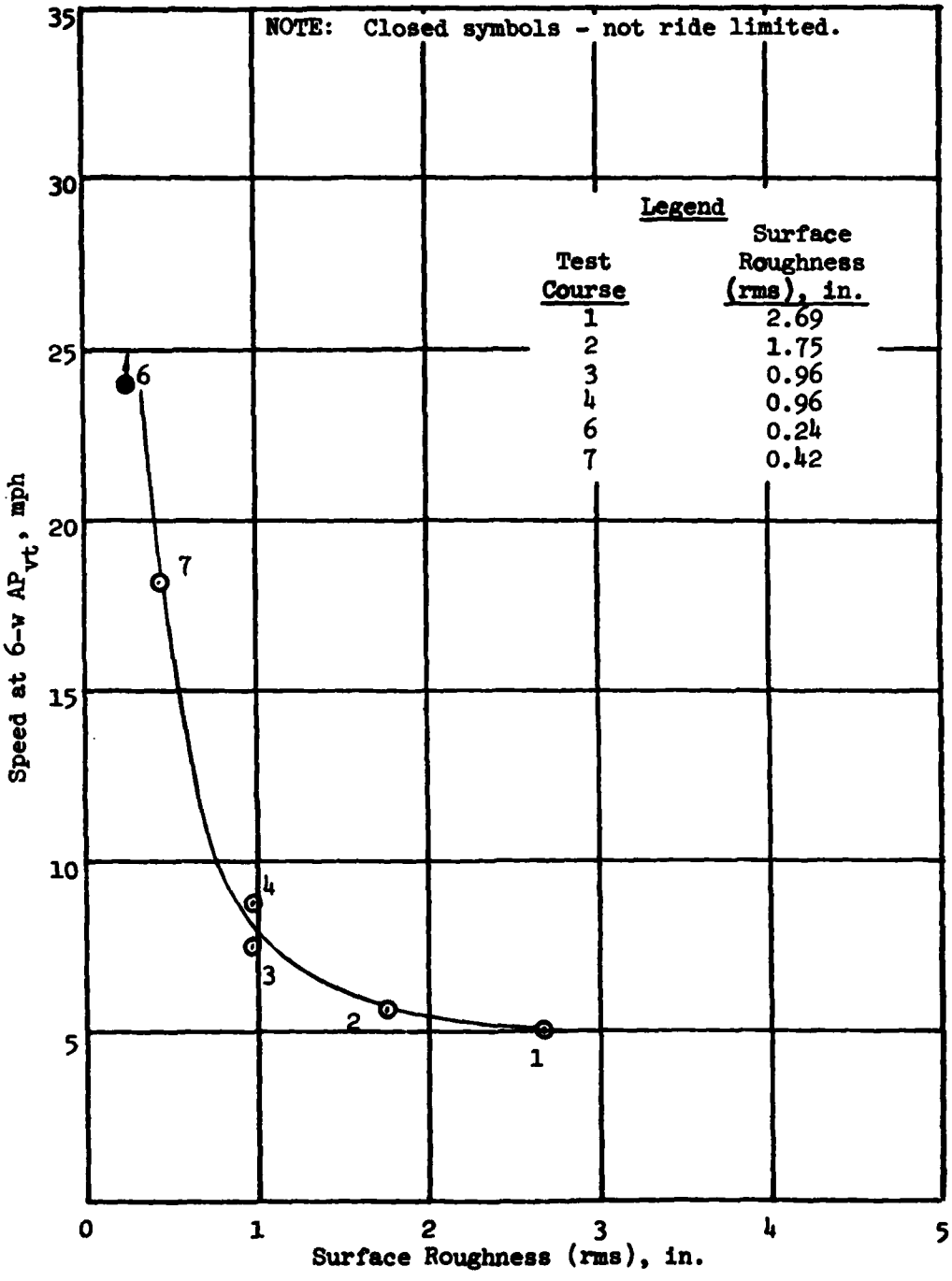
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
EMPTY, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 68



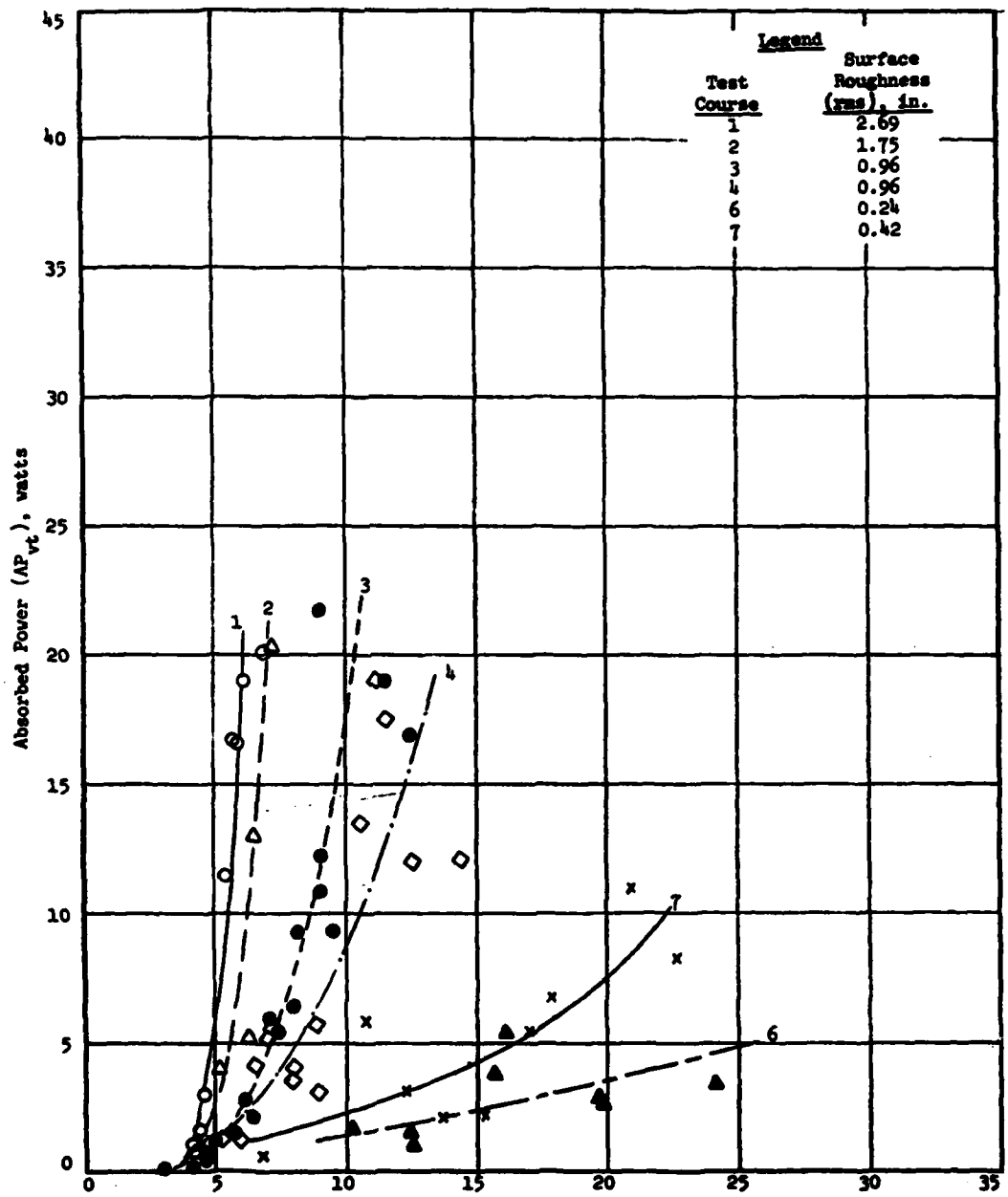
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
LOADED, 55-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 69



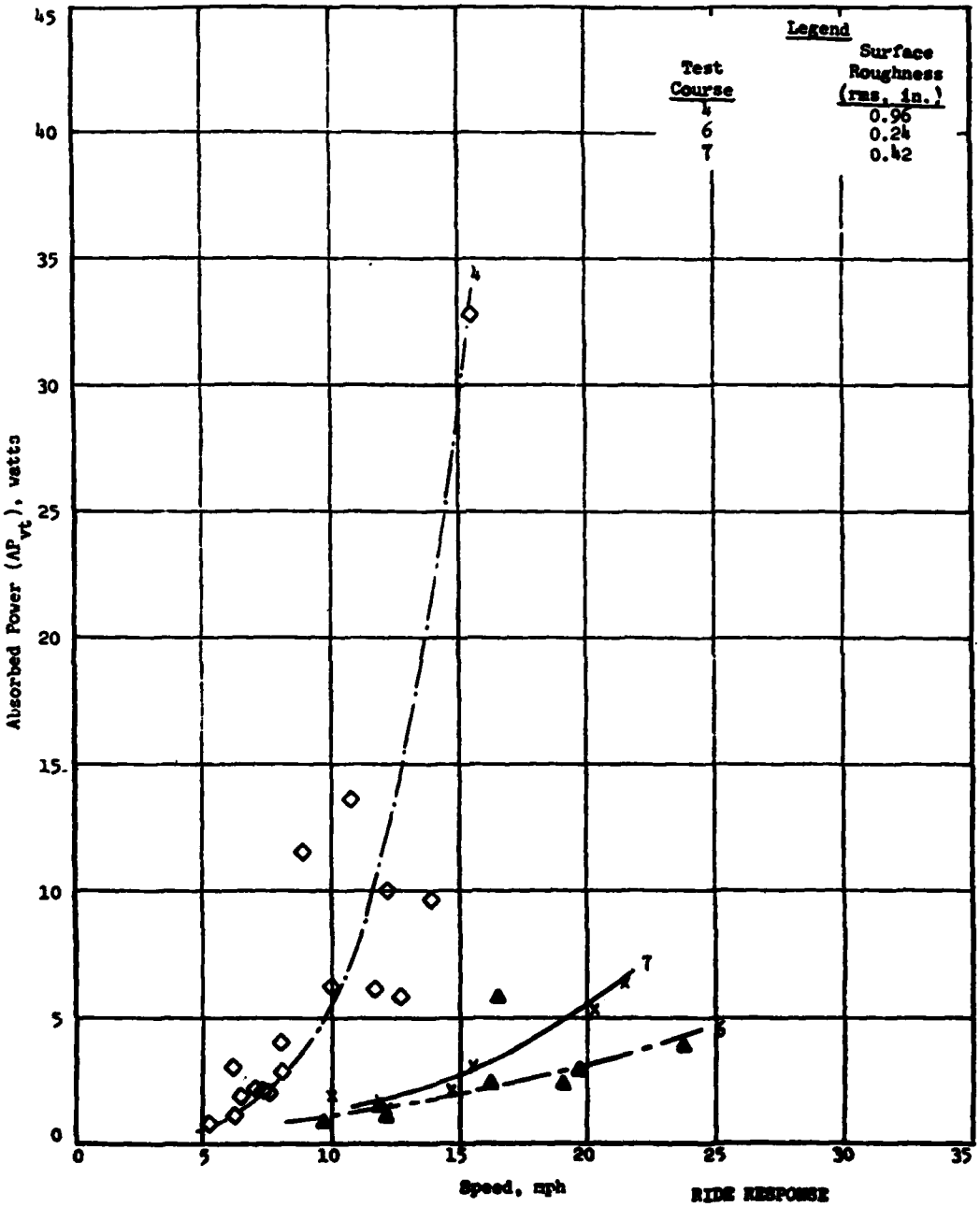
RIDE PERFORMANCE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
LOADED, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 70



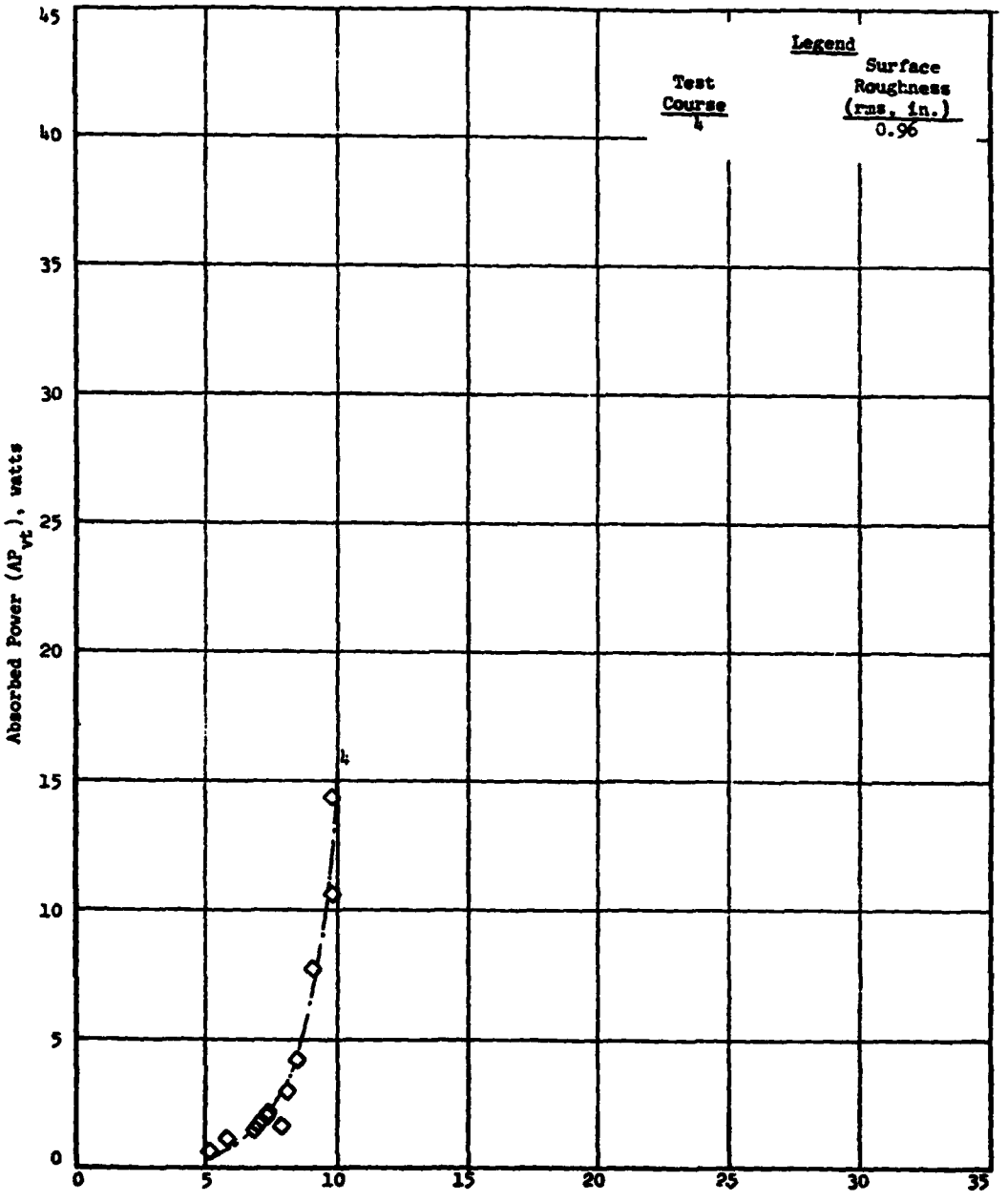
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
LOADED, 55-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 71



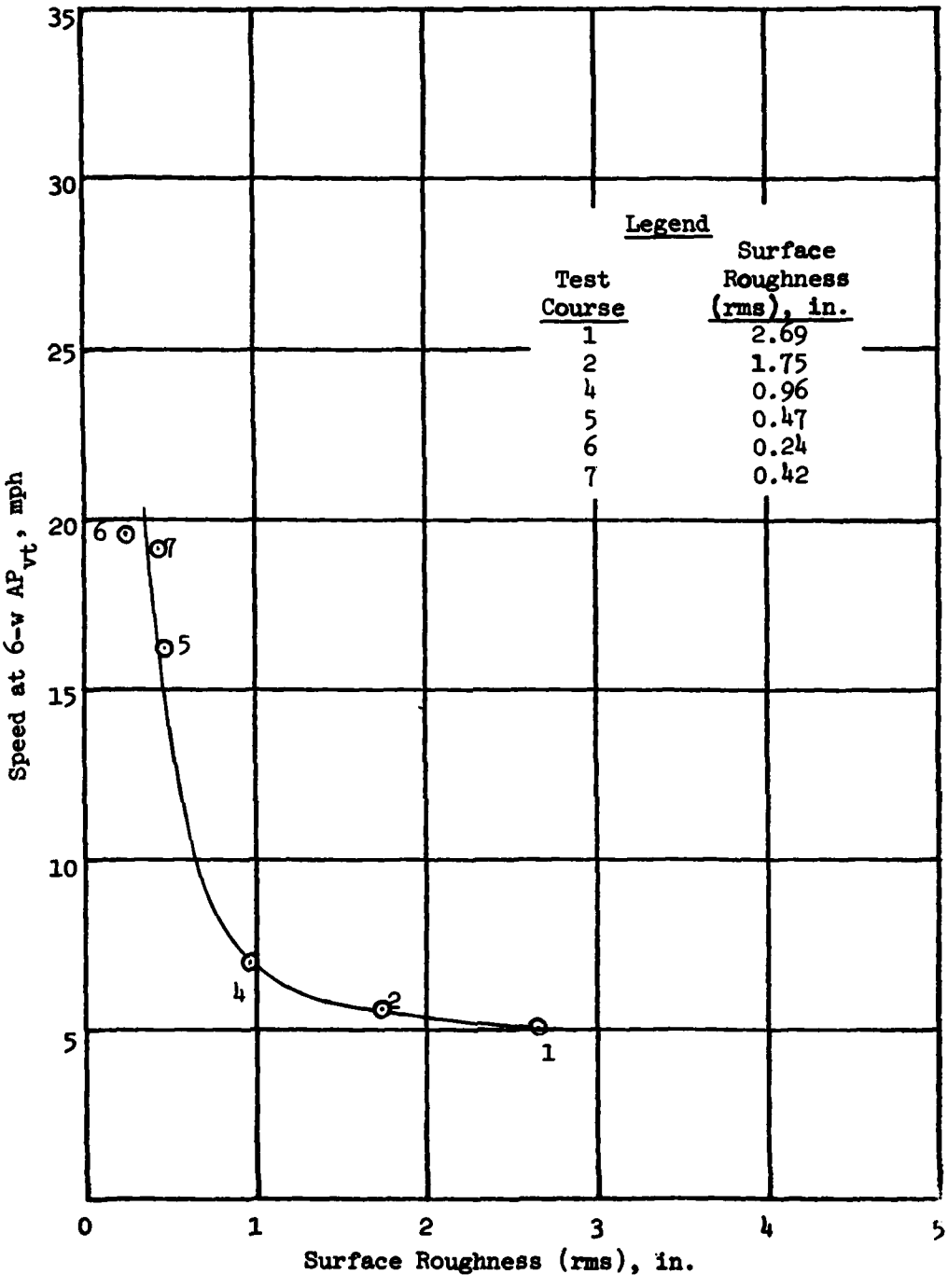
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
LOADED, 45-PSI TIRE PRESSURE, SEAT BLOCKED

PLATE 72



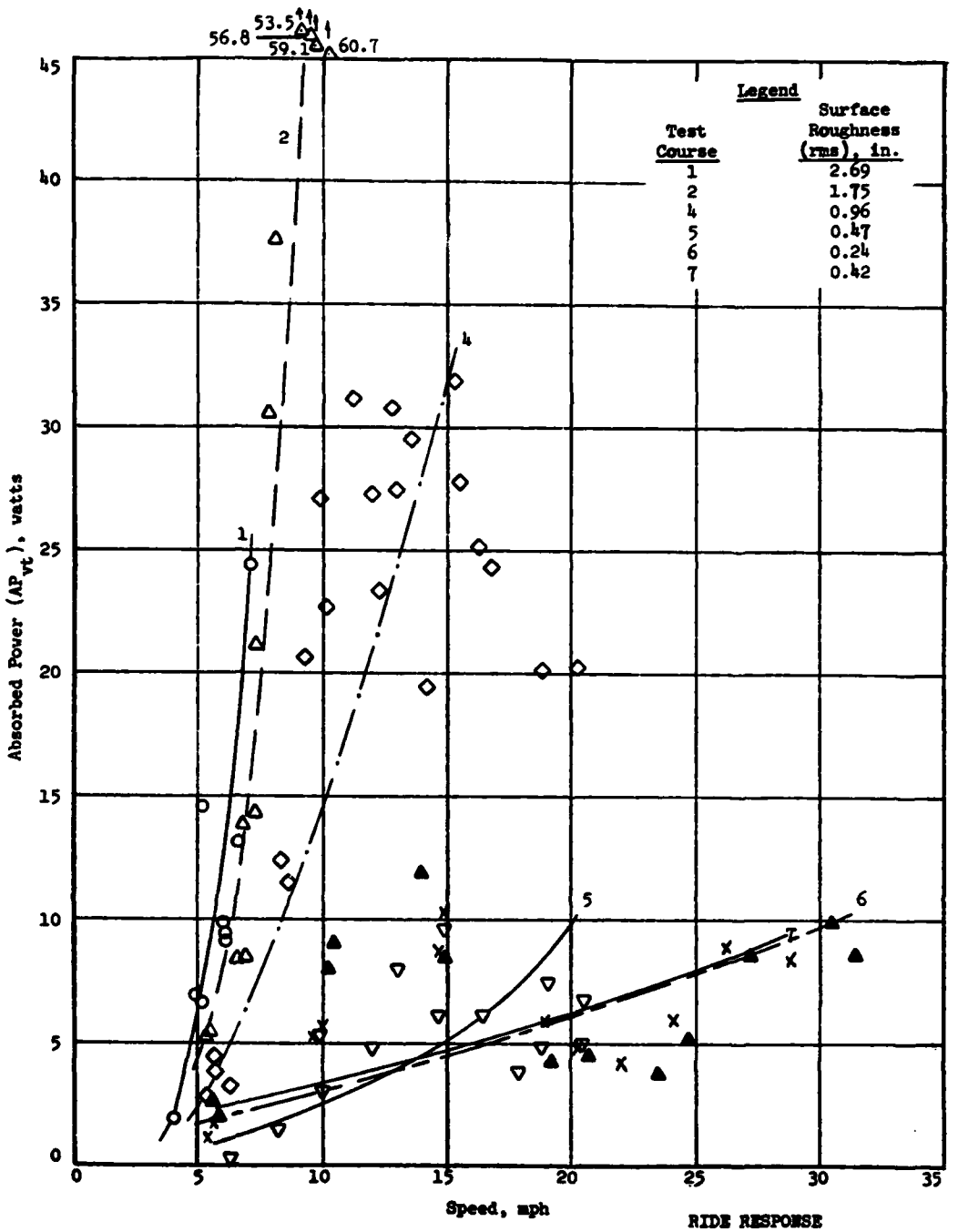
RIDE RESPONSE
FAMECE DUMPER
VERTICAL, REAR-CENTER CARGO, STEEL BED
LOADED, 45-PSI TIRE PRESSURE, SEAT UNDER PRESSURE

PLATE 73



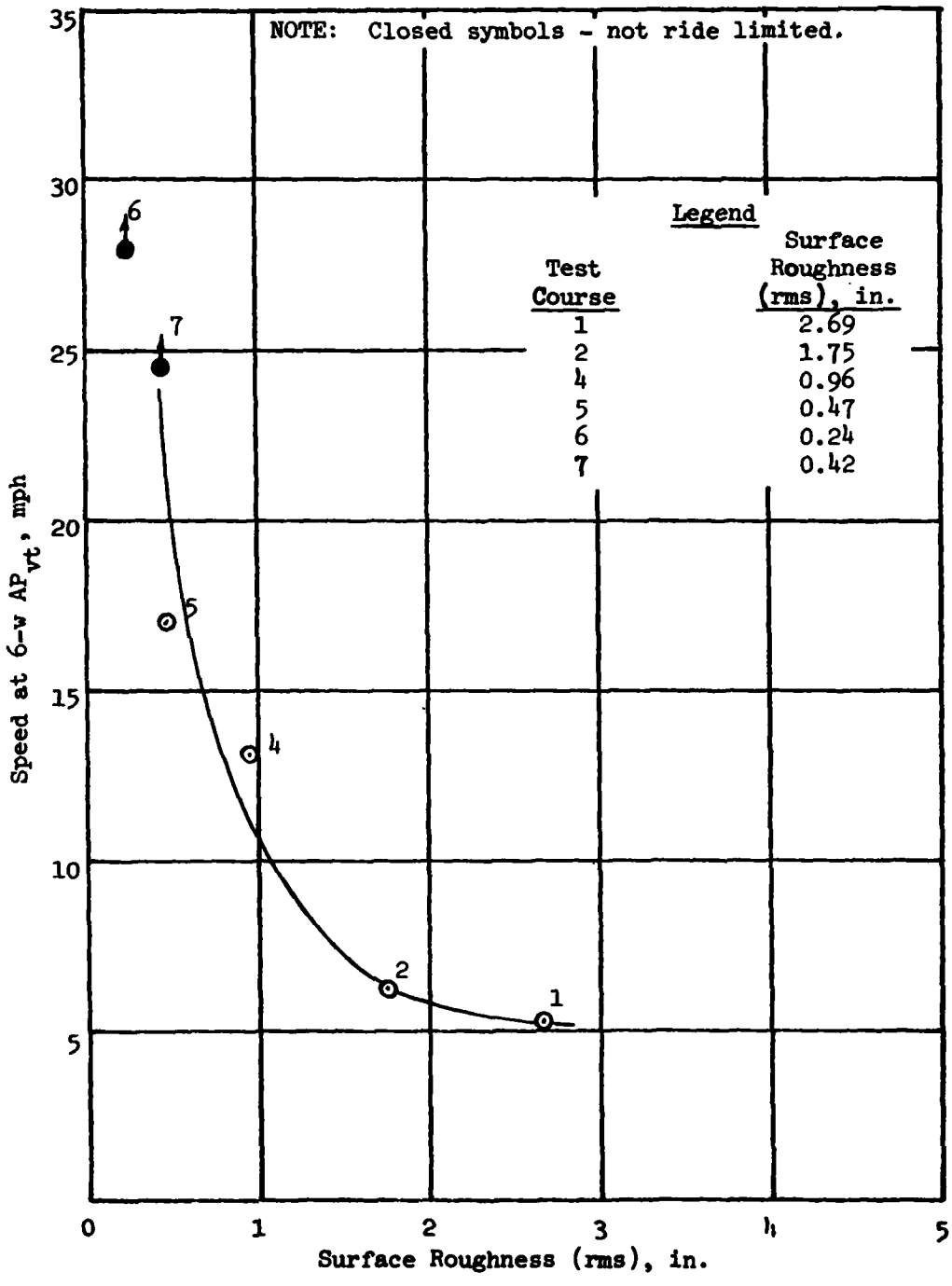
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, REAR-CENTER CARGO
STEEL BED, EMPTY, 35-PSI TIRE PRESSURE

PLATE 74



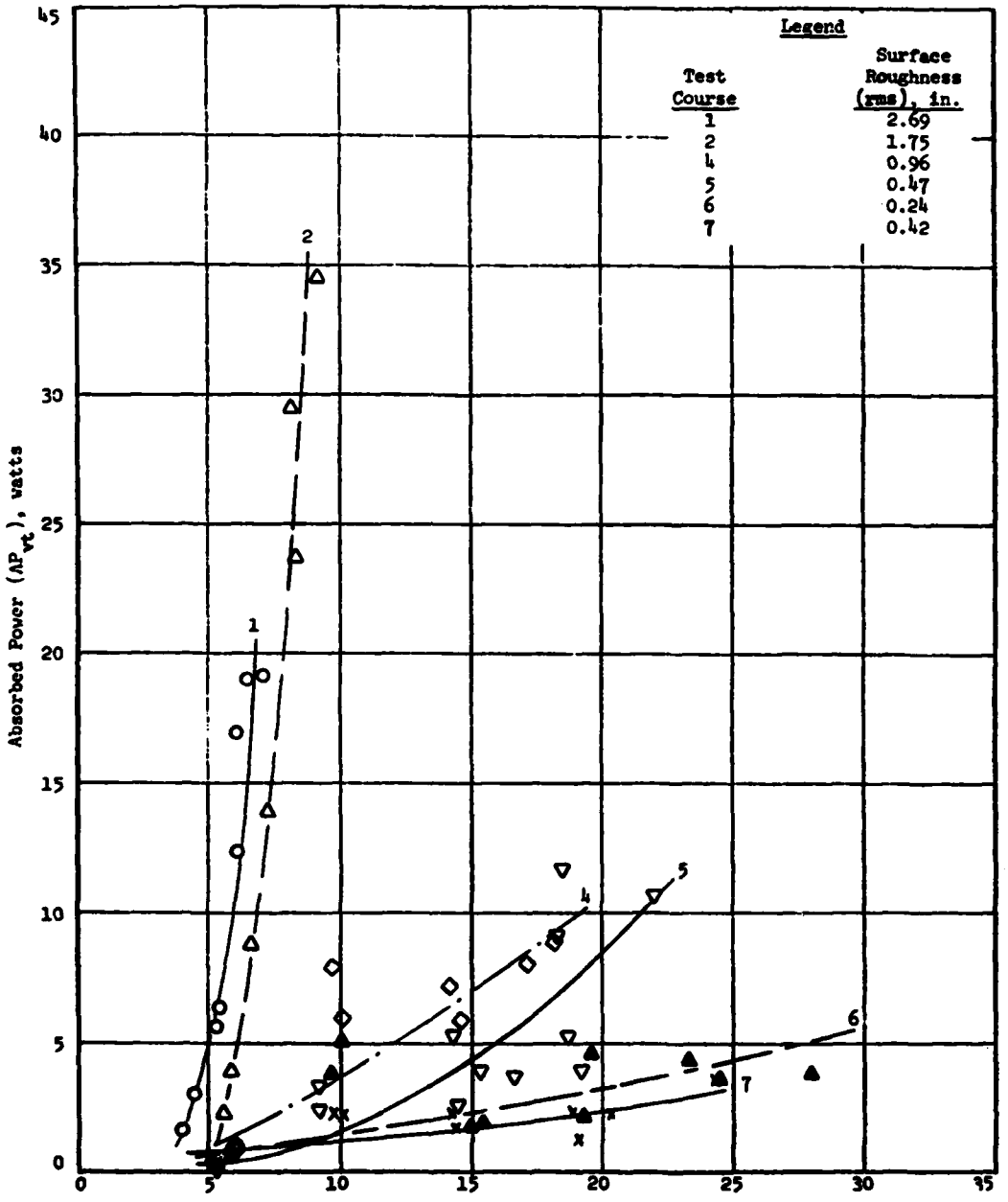
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, REAR-CENTER CARGO
STEEL BED, EMPTY, 35-PSI TIRE PRESSURE

PLATE 75



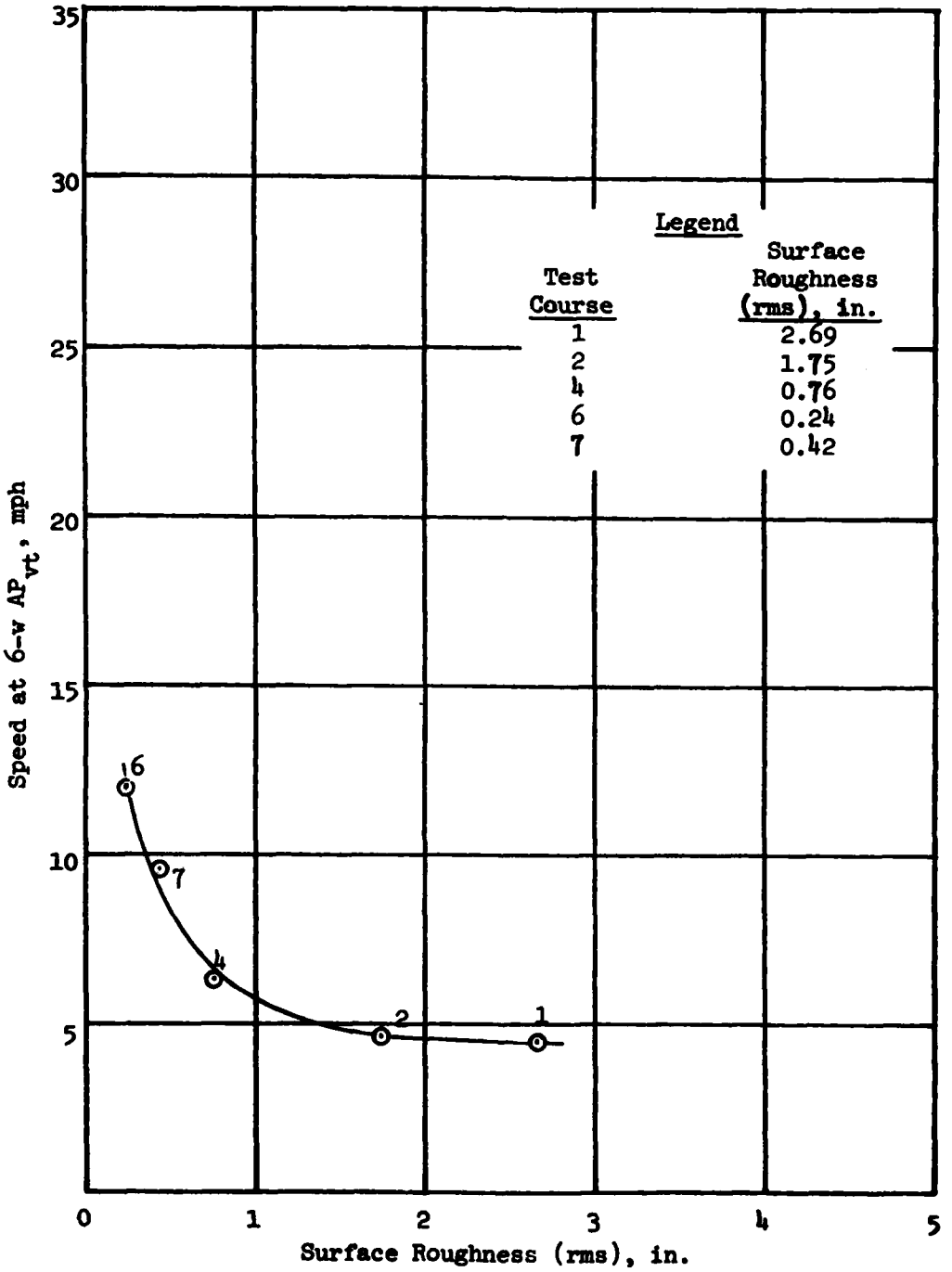
RIDE PERFORMANCE
M51, 5-TON DUMP TRUCK
VERTICAL, REAR-CENTER CARGO
STEEL BED, LOADED, 35-PSI TIRE PRESSURE

PLATE 76



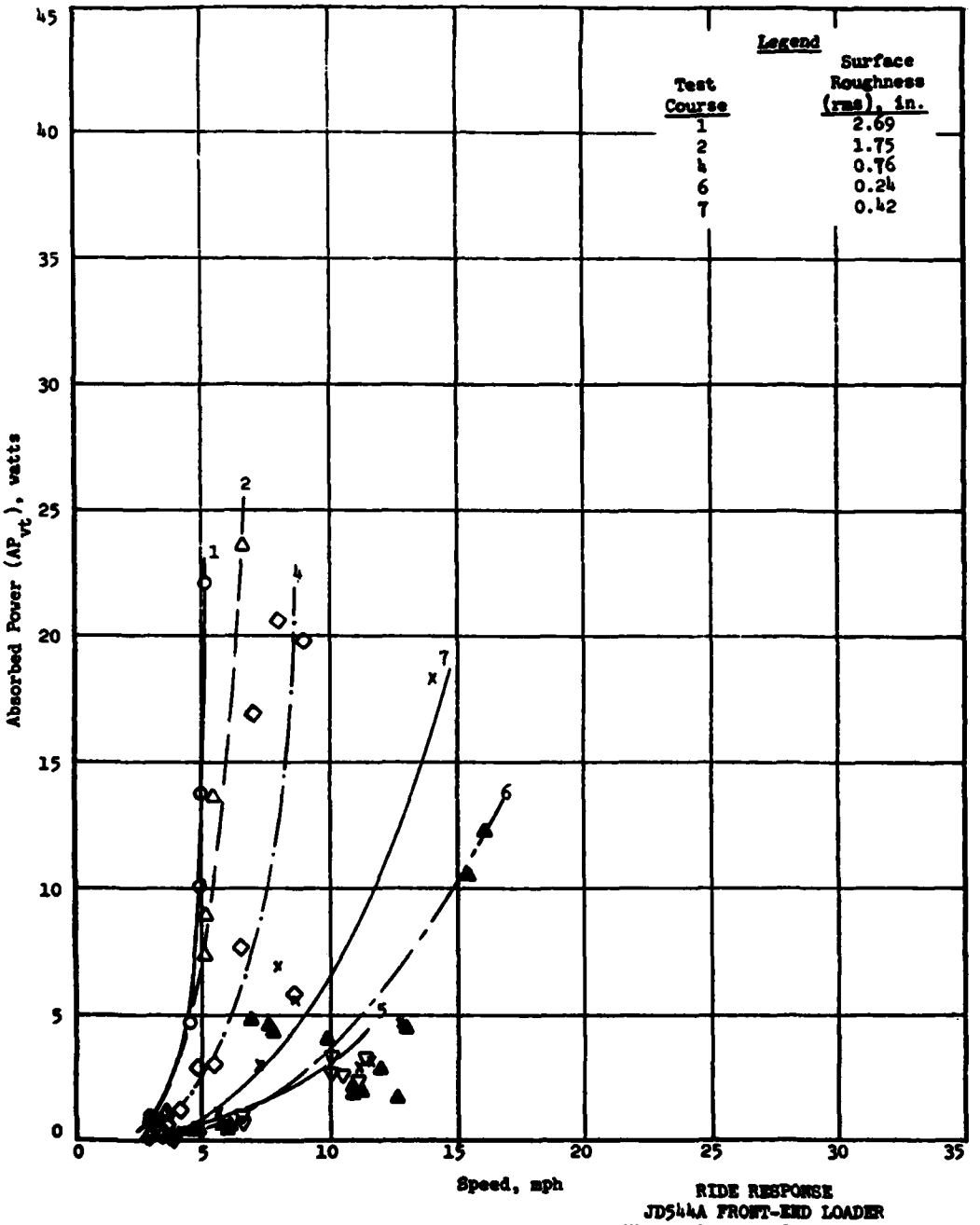
RIDE RESPONSE
M51, 5-TON DUMP TRUCK
VERTICAL, REAR-CENTER CARGO
STEEL BED, LOADED, 35-PSI TIRE PRESSURE

PLATE 77



RIDE PERFORMANCE
JD544A FRONT-END LOADER
VERTICAL, REAR-CENTER CARGO
STEEL BED, EMPTY, 50-PSI TIRE PRESSURE

PLATE 78



RIDE RESPONSE
JD544A FRONT-END LOADER
VERTICAL, REAR-CENTER CARGO
STEEL BED, EMPTY, 50-PSI TIRE PRESSURE

PLATE 79

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Willoughby, William E
  Ride test results for the FAMECE dumper and comparison vehicles / by William E. Willoughby. (Geotechnical Laboratory. U.S. Army Engineer Waterways Experiment Station) ; prepared for Project Manager, Family of Military Engineer Construction Equipment and Universal Engineer Tractor (FAMECE/UET), Fort Belvoir, Virginia under Project Order No. A9330. -- Vicksburg, Miss. : U.S. Army Engineer Waterways Experiment Station ; Springfield, Va. : available from NTIS, 1981.
  28, [1] p., [40] leaves of plates : ill. ; 27 cm. -- (Technical report / U.S. Army Engineer Waterways Experiment Station ; GL-81-1)
  Cover title.
  "January 1981."
1. Construction equipment. 2. FAMECE/UET (Project). 3. Loaders. 4. Military vehicles. 5. Ride dynamics. 6. Trucks. I. United States. Army Engineer Waterways Experiment Station. Geotechnical Laboratory. II. Title. III. Series: Technical report (United States. Army Engineer Waterways Experiment Station) ; GL-81-1.
TA7.W34 no.GL-81-1